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ON HIGHWAY EVALUATION OF SPLASH AND SPRAY ALLEVIATION DEVICES UNDER COLD WEATHER OPERATING CONDITIONS

PHASE II

FINAL REPORT

June, 1982

04-1201B-00

DeLCan Consulting
Engineers and Planners
Ottawa

DeLCan

1982 09 08

Our Ref.: 04-1201B-00

Dr. G.D. Campbell, P.Eng.
Director
Road and Motor Vehicle Safety Branch
Transport Canada
Tower C
Place de Ville
Ottawa, Ontario
K1A 0N5

Attention: Mr. Winson Ng

Dear Sir:

Re: Final Report - Evaluation of Splash & Spray Devices

We are pleased to enclose the final report for this project.

It is clear that significant build ups are propagated during cold weather when precipitation is present. This adds weight which requires a stronger mounting system to avoid failure. Performance was better than or equal to standard flaps under winter conditions. Limited data make it impossible to come to any further conclusions on device durability.

Yours very truly,

Paul Inglis

Paul F. Inglis, P.Eng.
Project Manager

PFI/lmb
Encl.

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1.0 INTRODUCTION

The risk of a traffic accident is greatly increased when visibility is reduced under adverse weather conditions. Several sources can contribute to a reduction in visibility such as the direct reduction in visibility due to precipitation intensity or due to reflectivity in the presence of road lighting and vehicle headlights during wet weather. A third source is the generation of water splash and spray from vehicles travelling at high speeds on a wet road. Because of the large number of wheels which are relatively open to the elements, large trucks tend to create a particular problem in this regard. The adverse impacts include:

- approaching traffic facing impaired visibility through the spray before the approach;
- approaching traffic experiencing a sudden and heavy shower striking the windshield, causing a panic reaction from some unprepared drivers;
- vehicles behind the spray producing vehicle experiencing impaired visibility through the dispersed spray as well as through a water covered windshield;
- headlights covered with road deposits decrease drivers' nighttime visibility distance;
- truck rear window and external rear mirrors become covered with road deposits resulting in reduced rear visibility;
- road signs become obscured and thus less legible.

The vehicle after market industry has developed add-on devices to reduce the effect of truck splash and spray on adjacent vehicle lanes. These devices operate on the principle of capturing a large portion of the splash and spray and converting it into a film or stream of water which falls to the road surface with minimum dispersion into the adjacent vehicle lanes.

Two devices have achieved significant commercial usage, namely the water collecting fenders and the textured wheel flaps with skirts. The latter device has received much more wide spread development and was selected for evaluation in this project.

The test device (shown on Figure 1) typically has two components, a longitudinal spray retention skirt mounted on a horizontal surface above the wheel and a special flap mounted vertically at the rear of the wheel. The two products tested are lined with rubber nodules (National Rubber) or "astroturf" (Monsanto). These textured surfaces trap the impacting water droplets, preventing them from dispersing, and causing them to coalesce into a stream of water which then drains from the bottom of the flap to the road surface. This type of device is effective, relatively inexpensive, easy to install, and can be used on virtually all types of trucks. This project is designed to determine whether its performance is susceptible to degradation under winter conditions as a result of ice or snow build-up, and whether its durability is markedly inferior to a standard flap.

1.2 Test Program Objectives

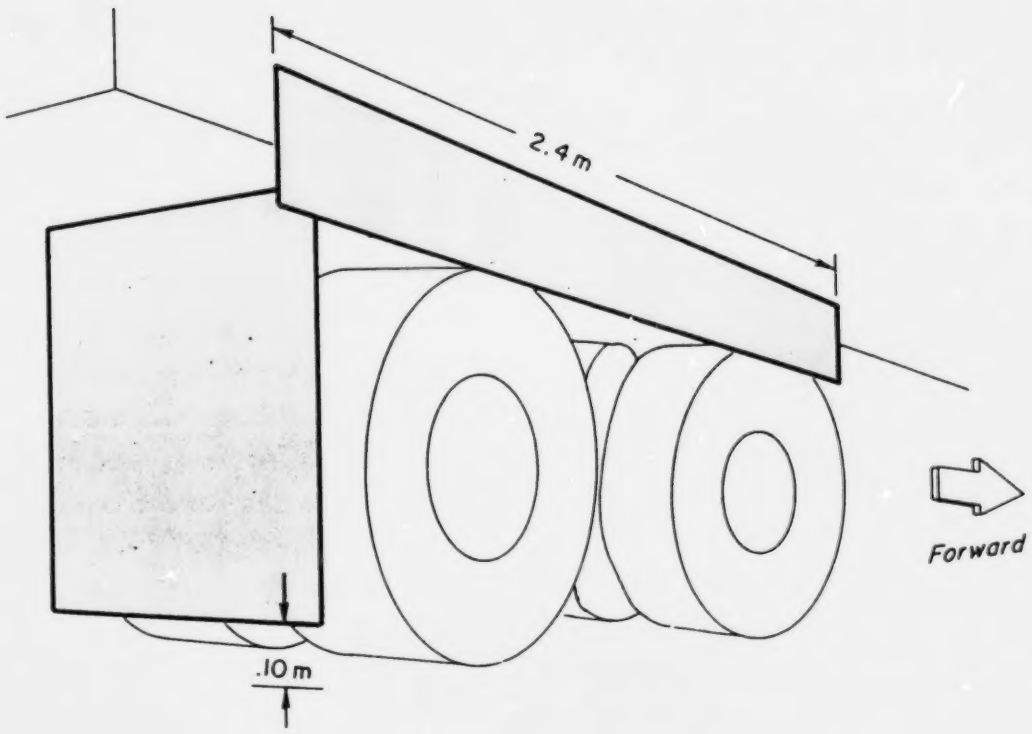
The objective of the test program described herein was to quantify in the Canadian winter context the performance of spray and splash alleviation devices. The particular areas of concern were:

(a) the occurrence of snow and ice build-up on the device and the vehicle underside;

(b) the effect of (a) on splash and spray dispersion;

(c) the effect of winter conditions on the durability of the device.

FIGURE 1
Typical Test Device Installation



1.3 Report Format

The report is structured as follows:

- Chapter 2 contains an overview of the test areas and equipment; the methodology and changes which were necessitated in the methodology during the project;

- Chapter 3 presents the results of both the telephone survey and the field data collection;

- Chapter 4 provides the recommendations and conclusions emanating from the study.

Attached to the report are appendices which provide:

(a) an instruction manual;

(b) the results of the telephone survey;

(c) a description of the test vehicles and;

(d) typical build-up data.

2.0 OVERVIEW OF THE TEST AREAS AND EQUIPMENT

A review of the literature in Phase I of this project clearly established that there is a benefit to the use of these devices in warm wet weather conditions. Clearly the devices reduce the amount of splash and spray. The primary question in terms of performance under cold weather conditions is to establish that the devices are no worse than standard vehicle flaps under the same conditions.

2.1 Test Program

The basis of the test program was to use existing commercial fleets to evaluate the device performance. The Canadian Trucking Association (CTA) arranged for six companies to participate in the project.

Vehicles operated from two locations; Toronto and Winnipeg. Table 2.1 summarizes the vehicles selected from the seven fleets. These particular fleets were selected on the basis of geographic and climatic coverage, type of vehicle (semi-trailer, tankers, box trailers) and the availability of dedicated tractor-trailer pairs.

An important test vehicle requirement was to have vehicles which were trailer tractor dedicated. This requirement was difficult to meet since most fleets do not operate in this mode. Imperial oil and Trojan Freight were two of the fleets which could comply. The Labatt and Molson fleets also agreed to operate their vehicles as dedicated pairs during the course of our study. Reimer and Kingsway did not operate as dedicated pairs. It was also desirable to have matching equipment which could be used as a control. This latter requirement was met by only Imperial Oil.

Two manufacturers agreed to supply splash and spray devices for the sample fleets - National Rubber and Monsanto. In total, twenty vehicles were equipped with Monsanto flaps, eighteen were equipped with National Rubber

TABLE 2.1

Fleet Selection

Fleet	Terminal Location	No. of Vehicles For Each Flap Type		
		Monsanto	National Rubber	Standard
Labatts	Toronto	3	3	1
Molsons	Toronto	3	3	1
Kingsway	Toronto	3	3	1
Trojan Freight	Toronto	1		
Imperial Oil	Toronto	4	4	2
Imperial Oil	Winnipeg	2	1	-
Reimer	Winnipeg	4	4	2
	Sub Total	20	18	7
	Grand Total		45	

flaps and seven vehicles were included in the study with standard flaps to provide the necessary control. New standard flaps were not installed, but all were checked to ensure that they were in very good condition.

The original schedule called for flaps to be installed during the summer periods. The Canadian Trucking Association did not identify the candidate trucking firms for the project until early in September. The firms were each contacted by the study team and a final selection of fleets was made on September 14th. A tentative schedule was arranged with the fleets and the manufacturers confirmed delivery dates. Neither manufacturer could supply the flaps on the original date of installation. Furthermore, the National Rubber representative did not meet the promised delivery date in Winnipeg.

Other difficulties with locating the above vehicles and gaining full cooperation of the trucking fleets were encountered at various times so that the installations could not all be done during the scheduled time period. Most installations were undertaken in Winnipeg on October 21st and October 22nd for Monsanto. National Rubber equipment did not arrive in Winnipeg until much later in the year so that installations of this equipment were not in place until December 3rd or 4th. Most Monsanto installations in Toronto were undertaken between October 26th and October 30th with a few installations remaining. The last installation was not completed at Imperial Oil in Toronto until January 27th, 1982.

In order to obtain sufficient durability data it was proposed that the project run from September until March 1982. Because of delays in installing the equipment it was decided to extend the exposure period through the full winter weather and complete the project by June 1st.

All installations were undertaken in the presence of manufacturer's representatives as often as was possible. The National Rubber flaps were installed using existing mounting brackets and their standard flaps. The Monsanto equipment was installed with special brackets supplied by Monsanto and using both Mark II and Mark III versions of their flaps.

Monsanto had intended to supply Mark III versions for all vehicles as these versions are designed to have greater life and to correct a problem with fatigue failure experienced with the Mark II versions.

Monsanto was extremely concerned with the possibility of fatigue failure with their flaps and accordingly provided mounting brackets for all vehicles which were equipped with spring loaded brackets at the time of installation. This type of bracket tends to reduce flap failure due to physical contact with obstructions during parking manoeuvers, and also avoids the vibration amplification caused by lighter spring type brackets.

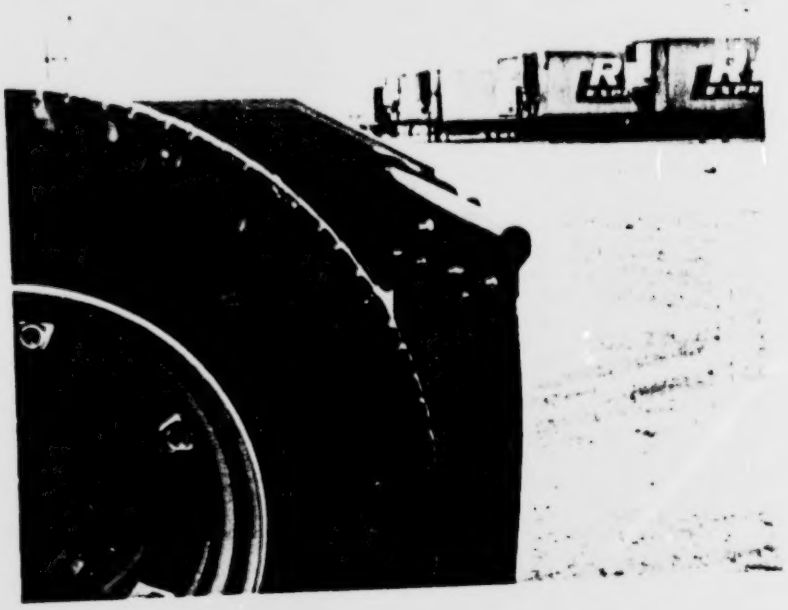
2.2 The Vehicles

The selection of the vehicle fleets took account of the geographic location and work cycle as well as of the vehicle configurations which would be studied. The selected vehicle mix included both conventional and cab-over tractors and a variety of trailers. Both vans and tankers were used in the study under both conventional and train configurations. Table 2.1 indicates the location and types of flaps for the survey. A total of 338 flaps were surveyed. In addition, fourteen other flaps were installed at Imperial Oil, however the vehicle was involved in an accident early in the project and was deleted from the study.

Imperial Oil, Labatts and Molson are all private carriers while Kingsway, Trojan and Reimer are all 'for-hire' carriers. The private carriers were able to ensure that their vehicle combinations were dedicated for the most part during the project. Trojan Freight, as a one-vehicle operation, was also dedicated during the project, however, this fleet was dropped during the study because with a duty cycle which took the vehicle away from home base for long periods, it was generally inaccessible. Kingsway and Reimer operated the tractors and trailers as independent units and therefore did not realize the full effectiveness of the devices.

FIGURE 2

Special Bracket used with
Monsanto Flap



Four trailer manufacturers were represented in the survey. Six different trailer manufacturers were included in this survey. Both dual-axle and tri-axle vans were included as were B-train configurations. Adjustable rear bogies were on some of the vehicles and tractors involved in the study were variously equipped with and without air deflectors. Both radial tires and bias ply tires were used on vehicles in the fleet.

A variety of mounting configurations were required depending upon the equipment at each location. In most cases the Monsanto flaps were mounted using the custom brackets as supplied by Monsanto. National Rubber were generally mounted using brackets already existing on the vehicles. In some cases, the flaps were mounted directly on the frame or on the fenders as appropriate.

2.3 Study Process

The study process was outlined in the Phase 1 report for this project dated May 1981. Subsequent to the issue of that report, one change was made in the methodology. The baseline visibility tests were dropped from the program and a telephone interview survey was added. This survey involved interviews of those companies which were using the test devices of either Monsanto or National Rubber manufacture.

Lists of customer contacts were received from both National Rubber and Monsanto and DeLCan staff contacted these users. The users were questioned concerning the performance of the devices, their durability and maintainability.

2.3.1 Build-up Observations

It was originally intended that each of the fleet managers would contact DeLCan staff when build-up occurred on any vehicle. DeLCan staff would then inspect the flaps, take photographs and record descriptions of build-ups.

By January it was apparent that the dispatchers were not cooperating in this regard despite a number of contacts by DeLCan staff. It was decided that DeLCan staff would contact the dispatchers directly upon observation of weather conditions which might be expected to produce build-up. These contacts would be followed up with observations. This approach resulted in mixed success.

The Ministry of Transportation and Communications of Ontario were also to provide notification of buildup as observed at inspection stations. This was also to be followed up by inspection and recording of pertinent data. As with the dispatcher, no calls were received despite a letter from head office on two occasions.

2.3.2 Durability

The durability observations were made by installing the flaps as soon as possible and monitoring their performance to observe problems with the flaps. At the end of the project inspections were to be made of each of the devices and comments made concerning deterioration. No change was made to this methodology which proceeded smoothly.

2.3.3 Over-the-road Testing

Over-the-road testing was to be conducted in Toronto using vehicles which were similarly configured but with a control and test type flap on each vehicle. Chase cars, equipped with camera equipment and CB radios, were to follow the vehicles making observations of performance where build-up occurred.

Great difficulty was encountered in trying to undertake these surveys. It was necessary to arrange for two vehicles from different locations, the study team members and the weather conditions all to be available at the same time. In order to have the vehicles available at the study section at the

proper time it was necessary to give 24 hours notice to the operators. It was necessary to rely upon weather forecasts for the appropriate conditions.

Seven different times during the study period appropriate weather conditions were forecast and contacts were made with the operator. On three of those occasions the vehicles could not be made available at the study location. On the four other occasions, at least one of the other vehicles and/or the weather conditions were not suitable. Therefore the over-the-road tests were not conducted.

2.3.4 Telephone Survey

The lists received from National Rubber and Monsanto provided a sample of test flap users. A total of 10 fleets were contacted in August, 1981 of whom 6 were testing both brands, 2 testing Monsanto only and 2 testing National Rubber only. Contacts were made a second time in June 1982 to follow up earlier interviews.

2.3.5 Supplementary Activities

In order to obtain opinions on the value of the flaps, driver interviews were held with those drivers operating the vehicles which were specially equipped. As well, interviews were held with the maintenance and management level representatives directly responsible for vehicle maintenance and operation in each of the fleets.

Buildup occurs during specific conditions of weather (temperature and precipitation). Accordingly, meteorological records were obtained and summarized for both Winnipeg and Toronto.

3.0 PROJECT RESULTS

This project has involved the collection of both subjective and objective data from a number of sources. In this chapter we present the results of the various activities undertaken during the project.

3.1 Telephone Interview

The project contacted a total of 10 fleets who are utilizing Monsanto, National Rubber or both flaps either on an operational or test basis. Subsequently, 3 of these fleets were included in Phase II of the project. In August 1981 the telephone interviews resulted in the following general conclusions.

For the Monsanto flaps (10 users), nine of the fleets reported flap failures as a result of cracking. Four fleets had discontinued use of the flaps. The remaining 6 fleets continued to test the flaps as long as they were replaced free of charge by the manufacturer.

Fleets using National Rubber product (8 fleets) were all still using the flaps. Of these 6 fleets were completely satisfied with the device performance and 2 fleets reported that there could be no comment on their performance because of limited experience. No failures were reported with the National Rubber devices.

Many of the fleets were using only the flaps and were not using the side skirts and thus did not receive full benefit of the devices. Many fleets indicated that there were operational reasons for not using the skirts. Most fleets indicated that there was a definite improvement in the visibility for the driver using the rear-view mirrors and a cleaner vehicle was noted by several of those interviewed. Several fleets indicated a higher maintenance cost

arising from the need to replace the flaps (in the case of Monsanto) and the need to clean the flaps more frequently. One company noted that ice got in the way of the driver when he tried to open and close valves on liquid fuel tankers. Those fleets which had undertaken winter testing all indicated a greater buildup than on the standard flaps. This buildup caused a problem with melting inside the shops in one case. It was also noted that mud tended to clog the flaps when the vehicle was operated on secondary roads.

In June 1982 the telephone interviews were repeated with the seven fleets not included in Phase II.

Flap failures continued to occur although the frequency was greatly reduced by the introduction of Mark III versions by Monsanto. Failures were usually associated with the use of spring mounts.

The side skirts were still not in use on most vehicles and one fleet had completely discontinued use of the flaps. On the other hand, four of the fleets (7 in total) were moving towards equipping all vehicles with the devices. Drivers in all but one of the fleets continue to agree that the devices give superior performance even during winter driving conditions. Most fleets noted the extra buildup and the need to 'kick the flaps clean' more frequently.

3.2 Field Data Collection

The results of the field data collection tasks are presented in terms of the four aspects under study: the build up of ice, snow and slush on the flaps, the improvement in visibility, operational problems and the durability of the flaps. The following subsections cover these topics individually.

3.2.1 Buildup Data

When the consultant was notified of the occurrence of buildup on flaps, an observer visited the operator, photographed the deposits, recorded the nature and dimensions of the individual flap deposits, and interviewed the driver to determine the location of the trip, weather conditions and road surface conditions.

Table 3.1a and 3.1b summarize the buildup data by operator and by each device-equipped test vehicle. The data presented in the tables include observation date, precipitation, ambient temperature and wind, road surface deposits, and a description of the type of flap deposits, the percentage of the flap area covered by deposits, the maximum thickness of the deposit, and an estimate of the weight of the deposit.

In the Winnipeg area, a total of 28 deposit observations were made on a fleet including 26 vehicles carrying a total of 86 test and 14 control flaps.

The area of the flaps covered with deposits typically ranged from 20% to 100% with the maximum deposit thickness being 20 cm and the maximum weight of deposit estimated at 36 kg per flap. The mean maximum thickness of all the Winnipeg observations is 8.0 cm with a standard deviation of 5.7 cm.

In Toronto, 5 observations of heavy buildup were made, ranging in thickness from 5 to 15 cm, and from 11 to 23 kg in weight.

It should be noted that in many cases the buildup of deposit on the flaps was reduced as a result of tire abrasion of the deposit which significantly changed both the quantity, weight and centre of gravity of the deposit. Initially the buildup is observed directly behind the tires and accumulates in the pattern shown in cross-section on Figure 3a. As buildup increases the thickness of the deposit in the higher areas increases more quickly than in the

TABLE 3.1a
Winnipeg Buildup Data

Vehicle No.	Device Type	Observ. Date	Weather			Road Surface	Deposit Description				Comments
			Precip.	Temp.	Wind		Type	% of Flap Area	Max. Thick	Est. Wt.	
TR 5669	Monsanto	4/2/82	lt. snow	-15°C	30 km/h	ice, snow, salt	lt. slush	50 to 100%	20 cm	3-10 kg	- deposits uniform
TR 5664	Monsanto	2/2/82	snow	-20°C	30 km/h	snow packed	slush & ice	50 to 100%	2 cm	-	- tractor not observed
TR 5664	Monsanto	5/4/82	hvy. snow	-10°C	40 km/h	ice & snow	ice & snow	20 to 100%	5 cm	1-9 kg	- curbside deposits heavier
TR 5680	Monsanto	3/2/82	hvy. snow	-20°C	30 km/h	slush & snow	slush & snow	5% to 60%	13 cm	0-6 kg	- curbside deposits heavier
TL 6167	Monsanto	2/3/82	snow & sleet	-10°C	40 km/h	slush & snow	ice & snow	50 to 100%	8 cm	10-18 kg	- deposits uniform
TL 6168	Monsanto	18/3/82	hvy. snow	-1°C	10 km/h	snow & wet	slush & ice	50 to 100%	5 cm	4-13 kg	- curbside deposits heavier
TL 6182	Monsanto	2/2/82	hvy. snow	-20°C	35 km/h	snow packed	snow & slush	N/A	8 cm	-	- trailer not observed
TL 6157	Monsanto	4/2/82	N/A	N/A	N/A	N/A	ice & snow	N/A	8 cm	0-3 kg	- no driver interview
TR 5607	National	3/2/82	sleet & snow	+2° to -30°C	20-90 km/h	ice & snow	ice & snow	40 to 90%	5 cm	4-8 kg	- front flap deposits non-uniform
TR 5666	National	8/2/82	lt. snow	-20° to -30°C	10 km/h	clear	ice & snow	20 to 100%	15 cm	5-9 kg	- -
TR 5668	National	18/3/82	snow & rain	0°C	light	snow	ice & snow	15 to 100$	10 cm	2-10 kg	- -
TR 5667	National										- no observations recorded
TL 6185	National	9/2/82	N/A	N/A	N/A	N/A	ice & snow	15 to 100%	3 cm	2-9 kg	- no driver interview
TL 6192	National	4/2/82	N/A	N/A	N/A	N/A	ice & snow	30 to 100%	4 cm	6-23 kg	- no driver interview
TL 6192	National	24/3/82	rain, snow	-1°C	10 km/h	ice & snow	NIL	-	-	-	- no build-up

N/A = not available

TABLE 3.1a (continued)
Winnipeg Buildup Data

Vehicle No.	Device Type	Observ. Date	Weather			Road Surface	Deposit Description				Comments
			Precip.	Temp.	Wind		Type	% of Flap Area	Max. Thick	Est. Wt.	
TL 6193	National	2/3/82	snow	-10°C	20 km/h	snow packed	ice & snow	20 to 80%	9 cm	2-12 kg	- curbside deposits heavier
TR 5608	Control	18/3/82	hvy. snow	-2°C	40 km/h	ice & snow	ice & snow	0% to 100%	3 cm	0-15 kg	- front flaps clear
TL 6119	Control	9/2/82	NIL	-30°C	20 km/h	NIL	ice & snow	5% to 10%	3 cm	1 kg	- curbside deposits heavier
TR 78-803	Monsanto	18/3/82	NIL	0°C	light	ice & slush	ice & slush	100%	8 cm	4 kg	- -
TL 78-822	Monsanto	18/3/82	NIL	0°C	light	ice & slush	ice & slush	100%	13 cm	14-31 kg	- max. deposit on rear of tandems
TR 78-800	Monsanto	3/2/82	NIL	-30°C	20 to 40 km/h	ice & snow	ice & snow	100%	8 cm	-	- front axle flaps removed
TL 78-824	Monsanto	3/2/82	NIL	-30°C	20 to 40 km/h	ice & snow	ice & snow	5 to 100%	5 cm	1-20 kg	- max. buildup on rear tandem flap
TL 78-825	Monsanto	3/2/82	NIL	-30°C	20 to 40 km/h	ice & snow	ice & snow	10 to 100%	8 cm	1-15 kg	- max. buildup on rear tandem flap
TR 78-804	National	8/2/82	lt. snow	-15°C	20 to 30 km/h	frost	ice & snow	60%	1 cm	2-3 kg	
TL 78-823	National	8/2/82	lt. snow	-15°C	20 to 30 km/h	frost	ice & snow	40%	3 cm	0-4 kg	
TR 78-801	Control	24/3/82	N/A	N/A	N/A	N/A	ice & slush	40 to 100%	2 cm	0-1 kg	- max. buildup behind tandems
TL 78-826	National*	24/3/82	N/A	N/A	N/A	N/A	ice & slush	40 to 100%	20 cm	2-36 kg	
TL 78-827	National*	24/3/82	N/A	N/A	N/A	N/A	ice & slush	40 to 100%	20 cm	4-20 kg	

N/A = not available

TABLE 3.1b
Toronto Buildup Data

Vehicle No.	Device Type	Observ. Date	Weather			Road Surface	Deposit Description				Comments
			Precip.	Temp.	Wind		Type	% of Flap Area	Max. Thick	Est. Wt.	
TL 8144	Monsanto	08/1/82	hvy. snow	-11°C	20-30 km/h	snow	snow	100%	9 cm	22 kg	- rear tandem flap
TL 78-531	National	30/1/82	wet snow	-30°C	5-10 km/h	lt. snow	snow & slush	100%	8 cm	11 kg	- pup tandem flap
TL 78-523	National	03/2/82	hvy. snow	-6°C	none	snow	snow	100%	13 cm	23 kg	- pup tandem flap
TL 80-530	Monsanto	03/2/82	hvy. snow	-6°C	none	snow	snow	100%	13 cm	23 kg	- pup tandem flap
TL 78-525	Monsanto	01/2/82	lt. snow	-11°C	20-25 km/h	lt. snow	snow	100%	8 cm	11 kg	- pup tandem flap

low areas. Because of the movement of the flap against the moving tires caused by vibration and wind effects the deposit is decreased immediately adjacent to the tires. This effect is a function of the mounting distance from the tires, the speed of the vehicle and flexibility of the flap. Figure 3b indicates the typical buildup patterns.

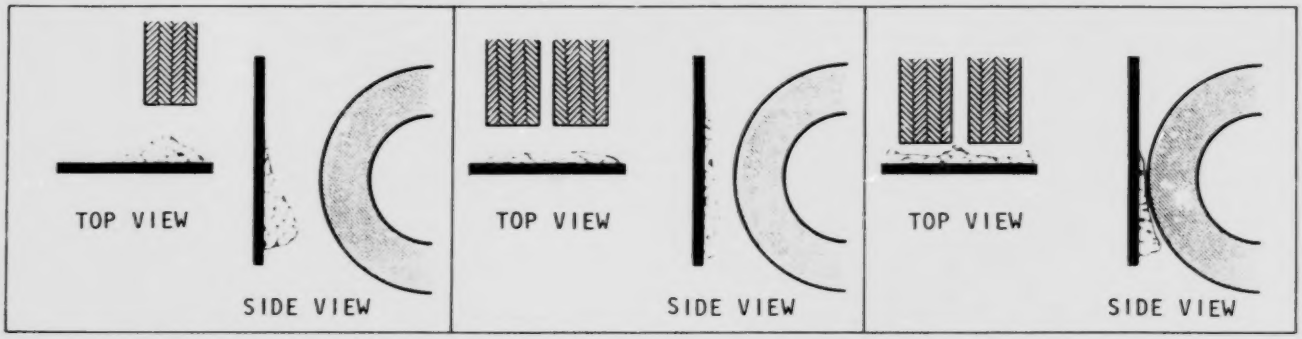
The greater buildup on the test flaps is a function of two factors both related to the presence of the grass-like material on the flaps. In the first place the texture provides a surface upon which initial buildup can be propogated. On a standard flap the buildup can be observed however it is seldom as large as on the test type flap. The second effect is the ability of the surface to support a greater volume of ice before the shearing effect causes the accumulation to drop from the surface.

Table 3.2 indicates a summary of the buildup mass for each of the observations. This table shows the number of flaps, the highest mass on any flap, the lowest mass on any flap, the total mass on the vehicle and the average mass per flap. The maximum mass for any flap was 36 kilograms on a National Rubber vehicle in Winnipeg. This vehicle also had the maximum total vehicle mass added of 164 kilograms.

Tables 3.3 and 3.4 indicate the location of the flap buildup and the relative amount of buildup by location. There does not seem to be any significant difference between the driver's side and the passenger's side. Of the 57 flaps surveyed on the driver's side the average mass was 8.3 kilograms per flap while on the passenger's side for the 56 flaps observed the average was 7.9 kilograms per flap.

There is a difference as the observations vary from axle to axle. The tractor front axle had 24 flaps observed for an average weight of 3.3 kilograms per flap while the tractor tandem axle observations of 26 flaps resulted in an average of 8.6 kilograms per flap. This result is to be expected since the area of the front flaps is much smaller than the area of the tractor tandem axle flaps.

FIGURE 3A
TYPICAL LIGHT BUILDUP PATTERNS ON FLAPS

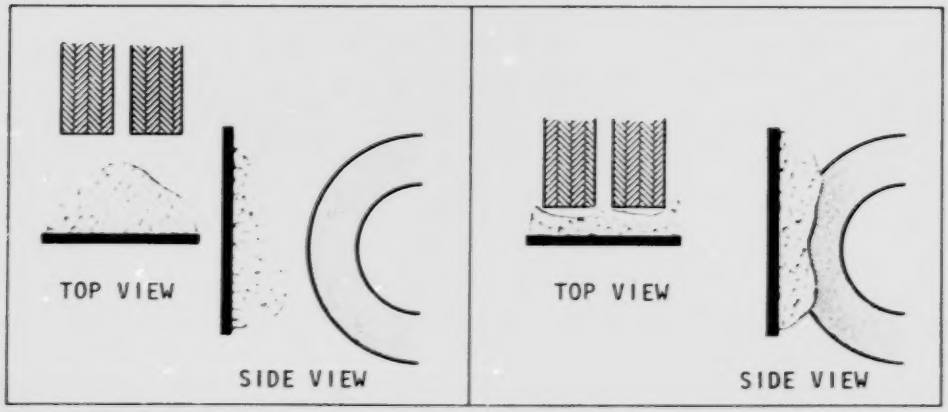


BEHIND FRONT WHEEL ON TRACTOR
NO TIRE RUB

BEHIND TRAILER TANDEMS
NO TIRE RUB

BEHIND TRAILER TANDEMS
WITH TIRE RUB

FIGURE 3B
TYPICAL HEAVY BUILDUP PATTERNS ON FLAPS



BEHIND TRACTOR TANDEMS
NO TIRE RUB

BEHIND TRAILER TANDEMS
WITH TIRE RUB

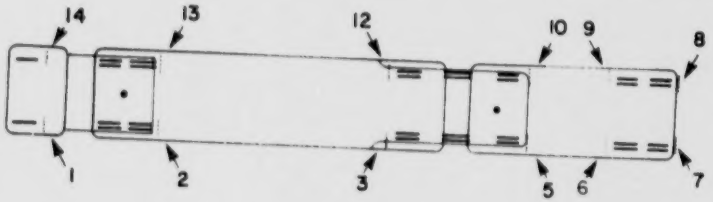
TABLE 3.2
Buildup - Summary

Fleet	Vehicle	Date	Flap Type	Buildup (kg) No.	High	Low	Total	Average
Imperial Oil Winnipeg	TR78-803/TL78-822	18/03	Mons.	8	31	4	137	17.1
	TR78-804/TL78-823	08/02	N.R.	6	4	0	13	2.2
	TR78-800/TL78-824-825	03/02	Mons.	10	20	1	83	8.3
	TR78-801/TL78-826-827	24/03	N.R	10	36	0	164	16.4
	TR78-801/TL78-826-827	26/02	Control	16*	13	0	47	2.9
	TR78-801/TL78-826-827	18/03	Control					
	TR78-801/TL78-826-827	24/03	Control					
			FLEET	50	36	0	444	8.9
Reimer Winnipeg	TL6167	02/03	Mons.	4	18	10	59	14.8
	TL6168	04/02	Mons.	4	13	4	39	9.8
	TL6157	04/02	Mons.	4	3	0	4	1.0
	TL6185	09/02	N.R.	4	9	2	23	5.8
	TL6192	04/02	N.R.	4	23	6	52	13.0
	TL6193	02/03	N.R.	4	12	2	27	6.8
	TL6119	09/02	Control	2	1	1	2	1.0
	TR5608	18/03	Control	4	15	0	15	3.8
	TR5666	08/02	N.R.	4	9	4	26	6.5
	TR5607	03/02	N.R.	4	8	4	24	6.0
	TR5664	05/02	Mons.	4	9	1	19	4.8
	TR5669	04/02	Mons.	4	10	3	27	6.8
	TR5668	18/03	Control	4	10	2	23	5.8
	TR5680	03/02	Mons.	4	2	0	4	1.0
			FLEET	54	23	0	344	6.4
Molsons Toronto	TR3679/TL8144	08/01	Mons.	1	-	-	22	22.0
			FLEET	1	-	-	22	22.0
Imperial Oil Toronto	TR79-512/TL78-530-531	30/01	N.R.	1	-	-	11	11.0
	TR81-501/TL78-522-523	03/02	N.R.	1	-	-	23	23.0
	TR79-511/TL80-529-530	03/02	Mons.	1	-	-	23	23.0
	TR79-514/TL78-524-525	01/02	Mons.	1	-	-	11	11.0
			FLEET	4	-	-	68	17.0
Kingsway Ottawa	TR51063	12/03 (1981)	Mons.	4	7	6	26	6.5
			FLEET	4	7	6	26	6.5
	24 vehicles, one observed twice ∴ 25 vehicles observed			113	36	0	904	8.0/flap 36.2/vehicle

* 12 flaps, 3 of which were observed three times.

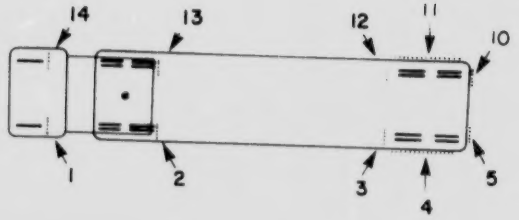
TABLE 3.3
Buildup By Location

City	Fleet	Vehicle Type		Number(s)	Flap Buildup (kilograms) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Test Tractor/Semitrailers																			
Toronto	Molson	Tractor Semi	(Mons.)	TR3679 TL8144	-	-	NA	NA	22	NA	NA	NA	NA	-	NA	NA	-	-	22
Ottawa	Kingsway	Tractor	(Mons.)		7	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6	7	26
Winnipeg	Imp. Oil	Tractor Semi	(Mons.)	TR78803 TL78822	4	28	17	NA	31	NA	NA	NA	NA	20	NA	19	14	4	137
Winnipeg	Imp. Oil	Tractor Semi	(NR)	TR78804 TL78823	-	2	0	NA	4	NA	NA	NA	NA	4	NA	0	3	-	13
Winnipeg	Reimer	Trailer	(Mons.)	TL6167	NA	NA	NA	15	16	NA	NA	NA	NA	18	10	NA	NA	NA	59
Winnipeg	Reimer	Trailer	(Mons.)	TL6168	NA	NA	NA	13	4	NA	NA	NA	NA	9	13	NA	NA	NA	39
Winnipeg	Reimer	Trailer	(Mons.)	TL6157	NA	NA	NA	0	0	NA	NA	NA	NA	3	1	NA	NA	NA	4
Winnipeg	Reimer	Trailer	(NR)	TL6185	NA	NA	NA	2	5	NA	NA	NA	NA	9	7	NA	NA	NA	23
Winnipeg	Reimer	Trailer	(NR)	TL6192	NA	NA	NA	16	6	NA	NA	NA	NA	7	23	NA	NA	NA	52
Winnipeg	Reimer	Trailer	(NR)	TL6193	NA	NA	NA	3	2	NA	NA	NA	NA	10	12	NA	NA	NA	27
Winnipeg	Reimer	Tractor	(NR)	TR5666	4	9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	8	26
Winnipeg	Reimer	Tractor	(NR)	TR5607	5	8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7	4	24
Winnipeg	Reimer	Tractor	(Mons.)	TR5664	2	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7	9	19
Winnipeg	Reimer	Tractor	(Mons.)	TR5669	5	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	9	27
				TR5680	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	2	4
				Total	27	64	17	49	90	NA	NA	NA	NA	80	66	19	47	43	502
				No. of Flaps	7	8	2	6	9	NA	NA	NA	NA	8	6	2	8	7	63
				Ave.	4	8	9	8	10	NA	NA	NA	NA	10	11	10	6	6	8
Control Tractor/Semitrailers																			
Winnipeg	Reimer	Trailer	(Cont'l)	TL6119	NA	NA	NA	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	2
Winnipeg	Reimer	Tractor	(Cont'l)	TR5608	0	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	15
Winnipeg	Reimer	Tractor	(Cont'l)	TR5668	6	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10	2	23
				Total	6	20	NA	NA	1	NA	NA	NA	NA	1	NA	NA	10	2	40
				No. of Flaps	2	2	NA	NA	1	NA	NA	NA	NA	1	NA	NA	2	2	10
				Ave.	3	10	NA	NA	1	NA	NA	NA	NA	1	NA	NA	5	1	4



B-TRAIN

N/A = Not Applicable
- = Buildup Not Observed



TRACTOR/ SEMITRAILER

TABLE 3.3 (continued)
Buildup By Location

City	Fleet	Vehicle Type	Number(s)	Flap Buildup (kilograms) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Test B-Trains																		
Toronto	Imp. Oil	B-Train (NR)	TR79512/ TL78530 TL78531	-	-	-	NA	-	-	-	11	-	-	NA	-	-	-	11
Toronto	Imp. Oil	B-Train (NR)	TR81501/ TL78522 TL78523	-	-	-	NA	-	-	23	-	-	-	NA	-	-	-	23
Toronto	Imp. Oil	B-Train (Mons.)	TR79511/ TL80529 TL80530	-	-	-	NA	-	-	-	23	-	-	NA	-	-	-	23
Winnipeg	Imp. Oil	B-Train (Mons.)	TR79514/ TL78524 TL78525	-	-	-	NA	-	-	11	-	-	-	NA	-	-	-	11
Winnipeg	Imp. Oil	B-Train (NR)	TR78800/ TL78824 TL78825	-	20	1	NA	10	1	15	11	3	4	-	1	17	-	83
			TR78801/ TL78826 TL78827	-	6	18	NA	16	13	20	4	18	2	NA	31	36	-	164
			Total	-	26	19	NA	26	14	69	49	21	6	NA	32	53	-	315
			All No.	-	2	2	NA	2	2	4	4	2	2	NA	2	2	-	24
			Ave.	-	13	10	NA	13	7	17	12	11	3	NA	16	27	-	13
Control B-Train																		
Winnipeg	Imp. Oil	B-Train (Cont'l)	TR78801/ TL78826 TL78827	1	5	13	NA	10	6	5	2	0	1	NA	2	1	1	47
Winnipeg	Imp. Oil	B-Train (Cont'l)	TR78801/ TL78826 TL78827	0	-	-	NA	-	-	-	-	-	-	NA	-	-	0	0
Winnipeg	Imp. Oil	B-Train (Cont'l)	TR78801/ TL78826 TL78827	0	-	-	NA	-	-	-	-	-	-	NA	-	-	0	0
			(3 different dates)															
			Total	1	5	13	NA	10	6	5	2	0	1	NA	2	1	1	47
			No. of Flaps	3	1	1	NA	1	1	1	1	1	1	NA	1	1	3	16
			Ave.	0	5	13	NA	10	6	5	2	0	1	NA	2	1	0	3

N/A = Not Applicable
- = Buildup Not Observed

TABLE 3.4

Average Buildup by Location

	Tractor/ Semitrailer with Control Flaps		Tractor/ Semitrailer with Reddaway Flaps		B-Train with Control Flaps		B-Train with Reddaway Flaps	
Flap Location	No. of Flaps	Ave. Buildup	No. of Flaps	Ave. Buildup	No. of Flaps	Ave. Buildup	No. of Flaps	Ave. Buildup
Driver Side	5	5 kg	32	8 kg	8	5 kg	12	13 kg
Passenger Side	5	3 kg	31	8 kg	8	1 kg	12	13 kg
Behind Front Wheels of Tractor	4	2 kg	14	5 kg	6	0 kg	-	-
Behind Tandem Axles of Tractor*	4	8 kg	16	7 kg	2	3 kg	4	20 kg
In Front of Tandem Axles on Semi-trailer	-	-	4	9 kg	2	8 kg	4	13 kg
Behind Tandem Axles on Semitrailer	2	1 kg	17	10 kg	2	6 kg	4	8 kg
In Front of Tandem Axles of Pup Trailer	NA	NA	NA	NA	2	3 kg	4	9 kg
Behind Tandem Axles on Pup Trailer	NA	NA	NA	NA	2	4 kg	8	15 kg
Skirts on Semitrailers	-	-	12	10 kg	NA	NA	NA	NA
Tractor Only	8	5 kg	30	6 kg	8	1 kg	4	20 kg
Trailer Only**	2	1 kg	33	10 kg	8	5 kg	20	12 kg

- no data

N.A. = not applicable

* includes flaps mounted on trailer behind tractor tandem axles.

** includes flaps on semitrailers and pups, but does not include skirts.

On the trailers there are a number of configurations depending upon the kind of vehicle being surveyed. The tankers all have flaps in front of the tandem wheel combinations as well as behind the tandem wheel combinations. For the semitrailers, the average mass buildup on flaps in front of the tandem axles was 10 kilograms for 10 observations while the flaps behind the tandem axles had an average buildup of 8.6 kilograms for 25 observations. On the second trailer of the B-train vehicles, average buildup on flaps in front of the tandem axles was 7 kilograms for 6 observations while an average buildup of 12.8 kilograms was experienced for 10 observations of flaps behind the rear tandem axles. The average mass for the skirt buildup is approximately 10.0 kilograms for a total of 12 observations. Figure 4 shows the average amounts by location for combination vehicles.

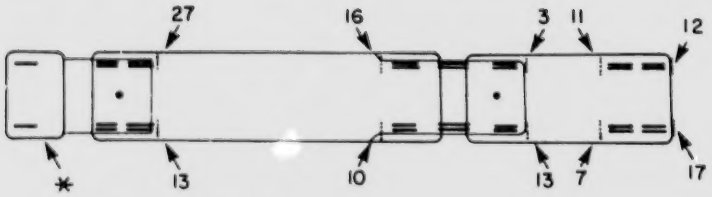
Table 3.5 indicates the comparison of quantity of buildup by type of device. It is apparent from this table that the buildup on National Rubber and Monsanto flaps is significantly greater than on Control vehicles (by a factor of approximately 3). It is also clear that the difference between Monsanto and National Rubber flaps is minimal in terms of the total estimated mass per flap.

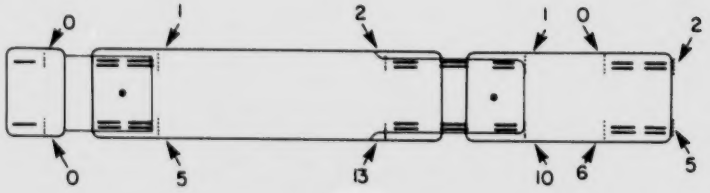
The quantification of the buildup mass has been described above. The second question to be posed and answered is the effect of temperature and the frequency of specific weather conditions which complicate the buildup on the flaps. Table 3.6 indicates the effect of temperature on buildup. Note that buildup occurred when there was no snow on a number of occasions. On each of these observations the winds were high and snow was blown into the vehicles from adjacent property. The table also shows the average mass per flap and the various temperature ranges. Note that most frequently observations were taken between 0°C and -10°C (55%). Also, the buildup was greater during this temperature range. The surprising result is the number of observations under -20°C.

FIGURE 4

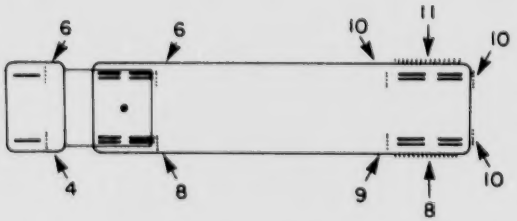
BUILDUP BY FLAP LOCATION - AVERAGE BUILDUP IN KILOGRAMS

B-TRAIN





TRACTOR/
SEMITRAILER



NEW DEVICE

CONTROL

* FLAPS NOT INSTALLED IN THESE LOCATIONS - BOTH SIDES OF VEHICLES

TABLE 3.5

Comparison of Device Performance

Flap Type	Number	Buildup (kg) High	Low	Total	Average
Monsanto					
I.O.L. - Winnipeg	18	31	1	220	12.2
I.O.L. - Toronto	2	-	-	34	17.0
Reimer - Winnipeg	24	18	0	152	6.3
Molson - Toronto	1	-	-	22	22.0
Kingsway - Ottawa	4	7	6	26	6.5
Overall	49	31	0	454	9.3
National Rubber					
I.O.L. - Winnipeg	16	36	0	177	11.1
I.O.L. - Toronto	2	-	-	34	17.0
Reimer - Winnipeg	20	23	2	152	7.6
Overall	38	36	0	363	9.6
Control					
I.O.L. - Winnipeg	16	13	0	47	2.9
Reimer - Winnipeg	10	15	0	40	4.0
Overall	26	15	0	87	3.3
	113	36	0	904	8.0

TABLE 3.6

Effect of Temperature on Buildup
Number of Flaps with Various Levels of Buildup

Level of Buildup		Temperature					
		+5°C to 0°C	0°C to -5°C	-5°C to -10°C	-10°C to -20°C	Less than -20°C	All Temperatures
none		0	3	0	2	0	5
very light	(<5kg)	1	7	4	5	7	24
light	(5-8kg)	2	7	1	2	3	15
light-medium	(9-12kg)	1	1	4	2	3	11
medium	(13-16kg)	0	3	2	0	2	7
medium-heavy	(17-20kg)	0	2	1	0	1	4
heavy	(21-24kg)	0	0	2	1	0	3
very heavy	(>24kg)	0	2	0	0	0	2
Number of Flaps		4	25	14	12	16	71*
Total Weight (kg)		23	191	151	73	111	549
Average Weight (kg/flap)		5.8	7.6	10.8	6.1	6.9	7.7

* this represents a sample of the total buildup observations.
Temperature at the time of remaining observations is unknown.

Table 3.7 indicates the influence of salt on the road on the mass of buildup on the flaps. Note here that the mass of buildup is apparently not significantly affected by the presence of salt. The single observation for sanded conditions cannot be deemed as 'typical'.

The heaviest buildups occur between the temperatures of 0° and -10°C when there is a significant snowfall. Above 0° the road surface will tend to have a larger water content and thus there is scouring of buildup from the flaps. Below -10°C the water content of the snow is small and thus the densities and overall buildup weight remains small. Tables 3.8 and 3.9 indicate the frequency of weather conditions occurring during the study period in Toronto and Winnipeg respectively. The study period comprised 169 days between October 28th and April 15th 1982. This study period also represents the only days during which the particular conditions might occur during the year. In Winnipeg it is estimated that there would be approximately 4 days where the worst conditions might occur. In Toronto it is estimated that approximately 10 days would occur where the worst possible weather conditions would be experienced.

3.2.2 Performance of the Devices

It has been determined that there is a buildup of ice and snow on the devices to a greater degree than on standard flaps. Given that this has been determined it is necessary to establish whether this buildup has a negative effect on the performance of the flaps. Logistical complications made it impossible to undertake the over-the-road testing as originally conceived at Phase I of this project. Accordingly the evaluation of performance of the flaps must be made based upon both the telephone survey and interviews with drivers and maintenance staff for the various fleets involved in the project.

During the course of the evaluation program both the service managers and drivers of the test vehicles were interviewed as part of the program. The reaction of management is mixed with respect to the maintenance and installation costs for the flaps. The drivers however seem to be positive

TABLE 3.7

Effect of Salt on Buildup
Number of Flaps with Various Levels of Buildup

Level of Buildup		Road Condition: Not Salted	Some Salt	Salted	Sanded	All
none		4	0	1	0	5
very light	(< 5kg)	17	4	3	0	24
light	(5-8kg)	10	5	0	0	15
light-medium	(9-12kg)	6	3	2	0	11
medium	(13-16kg)	5	0	2	0	7
medium-heavy	(17-20kg)	3	0	1	0	4
heavy	(21-24kg)	2	0	0	1	3
very heavy	(>24kg)	2	0	0	0	2
Number of Flaps		49	12	9	1	71*
Total Weight (kg)		374	78	74	23	549
Average Weight (kg/flap)		7.6	6.5	8.2	23	8.1

* this represents a sample of the total buildup observations. Road conditions regarding salting or sanding at the time of the remaining observations were unknown.

TABLE 3.8

Frequency of Weather Conditions

Toronto October 28th 1981 to April 15th 1982

Snowfall (cm)	Mean Temperature (0°C)			
	+5°C to 0°C	0°C to -4.9°C	-5°C to°C -9.9°C	-10°C & less
1.0	4	4	5	0
1.0-2.4	5	5	3	5
2.5-4.9	1	1	2	1
5.0-9.9	1	2	2	1
10.0+	0	0	3	0
	11	12	15	7

Assumptions: To have buildup, snowfall must be at least 2.5 cm with temperatures between 0°C and -10°C. ∴ number of potential buildup days = 10.

	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	OVERALL
TEMP.	SBN	N	SBN	BN	N	N	SBN	SBN
SNOW	MAN	MBN	SAN	SAN	N	N	SBN	N

MBN = Much Below Normal
BN = Below Normal
SBN = Slightly Below Normal
N = Normal
SAN = Slightly Above Normal
AN = Above Normal
MAN = Much Above Normal

TABLE 3.9

Frequency of Weather Conditions

Winnipeg - October 28th, 1981 to April 15th, 1982

Snowfall (cm)	Mean Temperature (0°C)				
	+5°C to 0°C	0°C to -4.9°C	-5.0°C to°C -9.9°C	-10°C to -19.9°C	-20.0°C & less
1.0	0	9	5	9	14
1.0-2.4	1	2	1	6	2
2.5-4.9	0	2	1	1	2
5.0-9.9	0	0	1	0	0
10.0+	0	0	0	0	0
	1	13	8	16	20

Assumptions: To have buildup, snowfall must be at least 2.5 cm with temperatures between 0°C and -10°C. ∴ number of potential buildup days = 4.

	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	OVERALL
TEMP.	SBN	AN	N	BN	N	N	N	N
SNOW	SBN	MBN	BN	AN	BN	BN	BN	BN

MBN = Much Below Normal
BN = Below Normal
SBN = Slightly Below Normal
N = Normal
SAN = Slightly Above Normal
AN = Above Normal
MAN = Much Above Normal

concerning the operation of the flaps. Of the 21 interviews conducted 9 indicated that the performance under buildup conditions was approximately the same as with standard flaps. Two drivers indicated that there was a small improvement while 10 indicated that there was definitely better performance with the test system. While this does not provide any quantitative data the qualitative result is clear; the test type flaps perform as well as or better than standard flaps under buildup conditions.

3.2.3 Operational Problems Encountered

The opinions of all the fleets utilizing the devices indicate that they do perform as designed and provide superior rear-view performance for trucks. However almost all fleets experienced additional problems associated with the vehicles.

(A) Monsanto provided heavy duty brackets for the installation of their flaps. This action in itself indicates that Monsanto recommend that extra strength brackets be provided when using their equipment. The experience of this project confirms that brackets will fall off as a result of the additional weight of the flaps themselves and the additional weight of ice and snow buildup. Companies installing the new flaps should be made aware that special brackets should be considered to avoid this problem.

(B) Mud Buildup - several drivers mentioned the problem associated with the buildup of mud on the flaps as opposed to snow and ice. Since the density of mud is likely to be at least double the density of snow and ice it is apparent that this type of buildup will cause the weight to be approximately doubled on the bracket and hence the need to further strengthen the mounting system.

(C) Interference with operations - a number of specific operational considerations must be considered when installing the flaps. Because

the flaps themselves are larger and stiffer than conventional mud flaps several operational problems arise. Imperial Oil experienced a problem with cab-over maintenance as a result of the stiffness of flaps which interfered with the forward tilt of the cab cover when accessing the engine. As a result they removed the flaps behind the steering axles.

Imperial Oil also had a problem associated with access to their tanker unloading valves because of increased buildup on the flaps. This is an unique problem associated with the location of valves for off-pumping products on one particular design of tanker.

On trailers with sliding bogies the bogies are fixed using a pin system which is accessed at the base of the van where the side skirts are normally installed. Each time the bogie was moved it was necessary to remove the skirt and as a result Kingsway removed the side skirts from their trailers in this study. This is a particular problem especially associated with vehicles which are piggy-backed.

Labatts found that in order to change tires it was necessary to remove the side skirts resulting in a higher maintenance cost for this item.

In general the flaps require more maintenance because it takes longer to clean them off during the winter and it takes longer to install them (approximately 3 times as long).

All of these factors contribute to a higher unit cost for the installation of the devices. Each of them must be considered in the analysis of the costs and benefits which could accrue to society as a result of a reduced accident rate.

3.2.4 Durability

One of the original objectives of the project was to determine the durability of the splash and spray control devices in comparison with standard flaps. The length of the test period was limited to seven months, including a full winter season, which was deemed to constitute a hostile working environment for the devices. It was anticipated during Phase I that the test period would result in mileages well below the manufacturer's claimed life for the devices, and that a very small number of failures might be observed.

Device Exposure

The two key elements in determining device durability or reliability are device exposure and the number of device failures, at a given point in time or accumulated distance. Table 3.10 presents a summary of the device exposure by device type within fleet, for a given geographic location. Exposure is measured in terms of kilometres accumulated by the vehicle bearing the devices, since the beginning of the test period. Since the devices on a given vehicle (tractor or trailer) are exposed to the same distance and environmental conditions, device exposure is tabulated in terms of device-kilometres rather than vehicle kilometres. This also reduces the confusion arising from the fact that different vehicles have varying numbers of flaps mounted. For example, 400,000 device-kilometres would be accumulated by a vehicle equipped with four flaps travelling 100,000 test kilometres.

In Table 3.10, it is shown that only four device failures were recorded within a total exposure of 19,626,020 recorded device-kilometres. Individual fleet device distance ranged from a high of 5,158,216 km to a low of 1,154,224 km during the test period.

TABLE 3.10
Summary of Device Exposure By Location, Fleet and Device

Location	Fleet	Type of Vehicle	Type of Device	Tot. Veh. Dist. (km)	Tot. Dev. Dist. (km)	Failure (# devices)	Mean Dist. To Fail (km)	Mean Time To Failure	Total # Failures	Total Dist. (km)
Winnipeg	Reimer	TR	M	366,282	1,465,128	1	97,880	4.5 mo	1	
Winnipeg	Reimer	TL	M	160,613	321,226	-	-	-		
Winnipeg	Reimer	TR	N	259,733	1,038,932	3	43,832	2.5 mo	3	
Winnipeg	Reimer	TL	N	137,131	274,262	-	-	-		
Winnipeg	Reimer	TR	C	219,506	878,024	-	-	-		
Winnipeg	Reimer	TL	C	83,468	166,936	-	-	-		
Sub-totals									4	4,144,508
Winnipeg	Imperial	TR	M	160,000	320,000	-	-	-	-	
Winnipeg	Imperial	TL	M	224,000	1,216,000	-	-	-	-	
Winnipeg	Imperial	TR	N	152,000	304,000	-	-	-	-	
Winnipeg	Imperial	TL	N	224,000	1,200,000	-	-	-	-	
Winnipeg	Imperial	TR	C	72,000	144,000	-	-	-	-	
Winnipeg	Imperial	TL	C	*	*	-	-	-	-	
Sub-totals									Ø	3,184,000
Toronto	Imperial	TR	M	164,726	658,904	-	-	-	-	
Toronto	Imperial	TL	M	329,452	1,647,260	-	-	-	-	
Toronto	Imperial	TR	N	203,718	814,872	-	-	-	-	
Toronto	Imperial	TL	N	407,436	2,037,180	-	-	-	-	
Toronto	Imperial	TR	C	*	*	-	-	-	-	
Toronto	Imperial	TL	C	*	*	-	-	-	-	
Sub-totals									Ø	5,158,216
Toronto	Molson	TR	M	218,896	875,584	-	-	-	-	
Toronto	Molson	TL	M	218,896	875,584	-	-	-	-	
Toronto	Molson	TR	N	209,300	837,200	-	-	-	-	
Toronto	Molson	TL	N	209,300	837,200	-	-	-	-	
Toronto	Molson	TR	C	36,352	145,408	-	-	-	-	
Toronto	Molson	TL	C	36,352	145,408	-	-	-	-	
Sub-totals									Ø	3,716,384

* data not available for these vehicles

TABLE 3.10 (Continued)
Summary of Device Exposure By Location, Fleet and Device

Location	Fleet	Type of Vehicle	Type of Device	Tot. Veh. Dist. (km)	Tot. Dev. Dist. (km)	Failure (# devices)	Mean Dist. To Fail (km)	Mean Time To Failure	Total # Failures	Total Dist. (km)
Toronto	Labatts	TR	M	149,032	596,128	-	-	-	-	
Toronto	Labatts	TL	M	149,032	596,128	-	-	-	-	
Toronto	Labatts	TR	N	95,437	381,748	-	-	-	-	
Toronto	Labatts	TL	N	95,437	381,748	-	-	-	-	
Toronto	Labatts	TR	C	39,117	156,468	-	-	-	-	
Toronto	Labatts	TL	C	39,117	156,468					
Sub-totals									Ø	2,268,688
Toronto	Kingsway	TR	M	144,330	577,320	-	-	-	-	
Toronto	Kingsway	TL	M	*	*	-	-	-	-	
Toronto	Kingsway	TR	N	113,034	452,136	-	-	-	-	
Toronto	Kingsway	TL	N	*	*	-	-	-	-	
Toronto	Kingsway	TR	C	31,192	124,768	-	-	-	-	
Toronto	Kingsway	TL	C	*	*	-	-	-	-	
Sub-totals									Ø	1,154,224
TWO LOCATIONS SIX FLEETS							GRAND TOTAL:		4	19,626,020

* data not available for these vehicles

Table 3.11, below, indicates the total number of devices for which test data were recorded:

TABLE 3.11
Number of Test Devices

TYPE	Winnipeg	Toronto	Total
Control	14	20	34
Monsanto	44	102	146
National	42	102	144
TOTAL	100	224	324

During the course of the test, some devices were dropped from the study because of vehicle accidents or deliberate removal by the fleet operator, when the devices interfered with maintenance or operational procedures. Nevertheless, with a total of 324 devices accumulating a total of 19,626,020 recorded kilometres over the test period, the device exposure was deemed to be both adequate and representative of typical line haul fleet operations.

In assessing the durability or reliability, it is necessary to examine both the average and the maximum distance accumulated by the various devices. These data are presented in histogram form for the three devices, in Winnipeg and Toronto, both separately and combined, in Figures 5 though 7.

In examining Figure 5, it can be seen that, in Winnipeg, the average mileage per device ranges from a low of 62,667 km for the National device, to a high of 84,268 km for the control device. The mean distance for Monsanto and National devices is quite well matched, as they are within one-half of a standard deviation of each other. Examining Figure 6 for Toronto indicates

FIGURE 5
DEVICE EXPOSURE
WINNIPEG

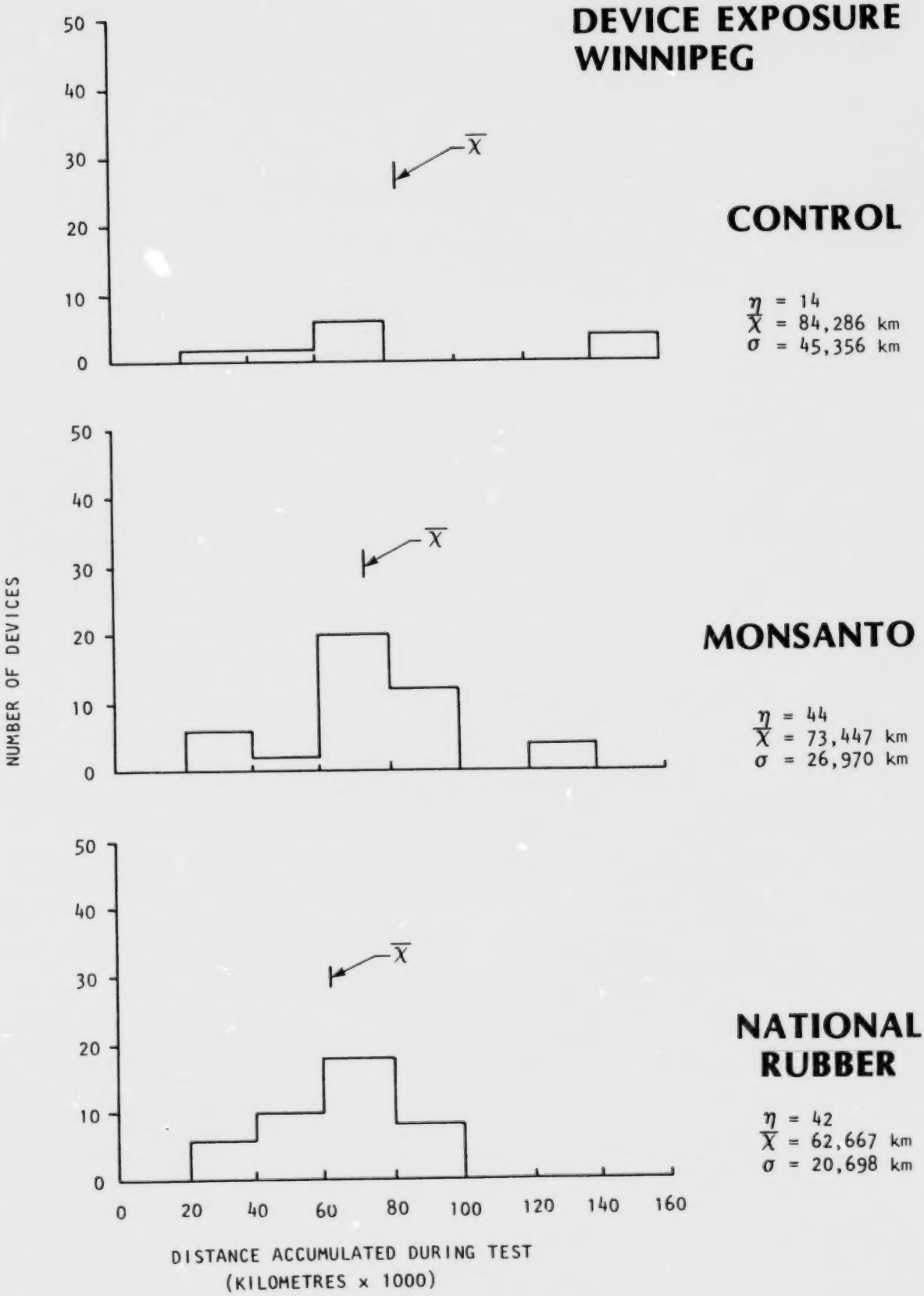
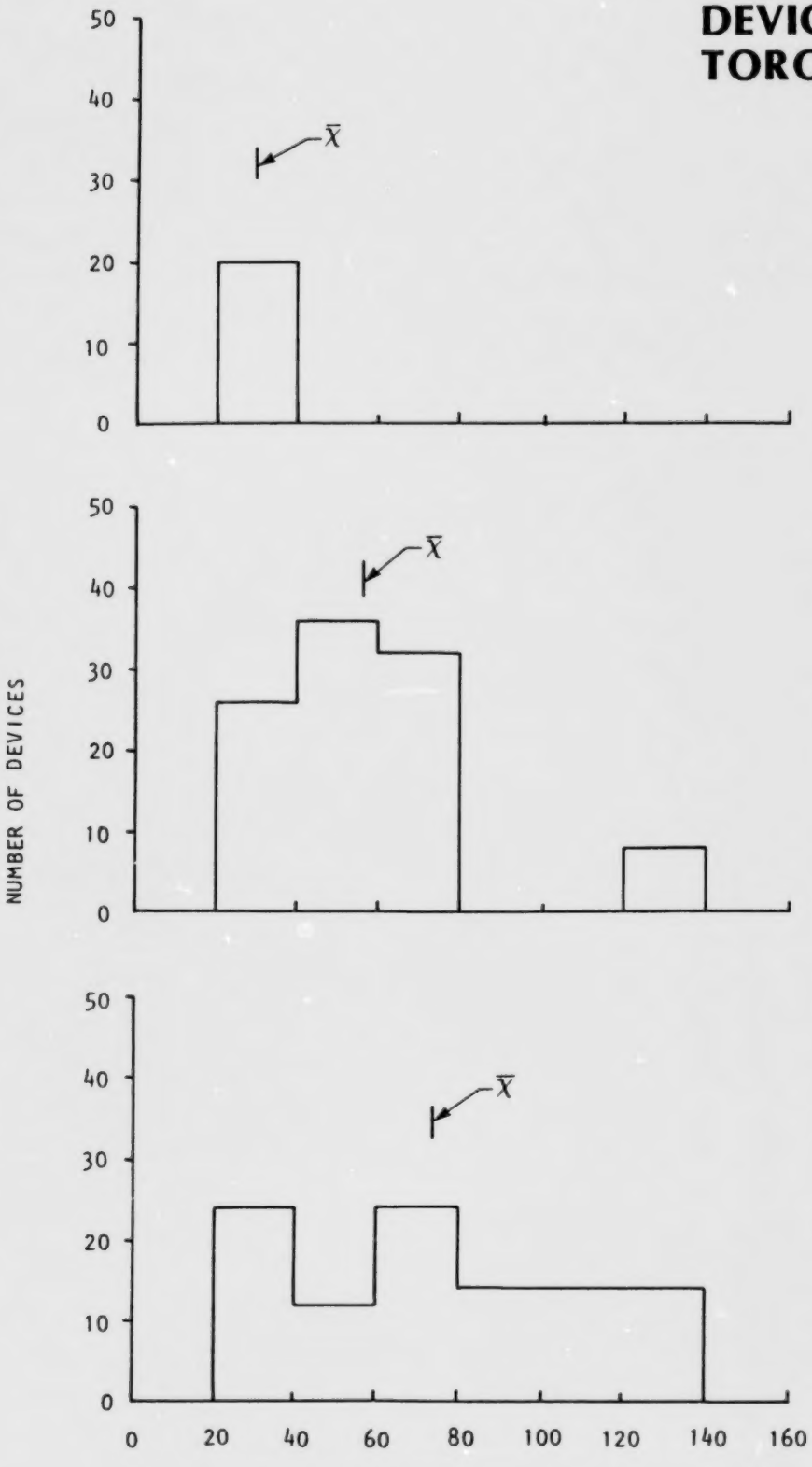


FIGURE 6
DEVICE EXPOSURE
TORONTO



CONTROL

η = 20
$\bar{X}$ = 30,000 km
σ = 0 km

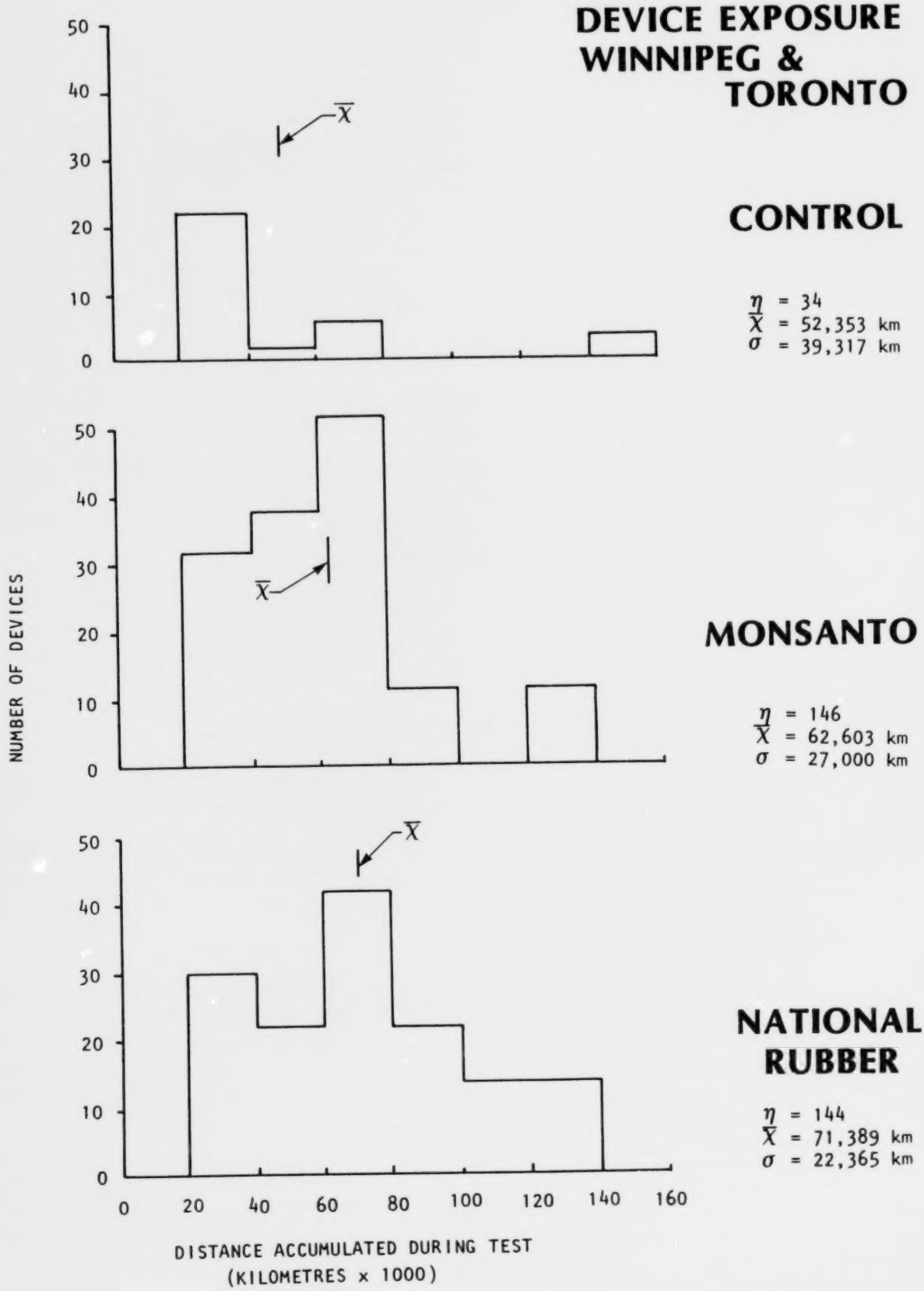
MONSANTO

η = 102
$\bar{X}$ = 57,450 km
σ = 26,088 km

NATIONAL RUBBER

η = 102
$\bar{X}$ = 74,706 km
σ = 34,374 km

FIGURE 7
DEVICE EXPOSURE
WINNIPEG & TORONTO



that the National devices were exposed to significantly higher distances than either the Monsanto or the control devices. When the data from the two locations are aggregated, as in Figure 7, the mean distance accumulations for National and Monsanto fall within 10% of each other, with the mean control device exposure being considerably lower.

Table 3.12 below presents the total exposure for each device and geographic location for which distance data are available. Note that the control distance is under estimated to a greater extent.

TABLE 3.12

Aggregated Exposure Data

	TOTAL DISTANCE ACCUMULATED (km)		
DEVICE TYPE	Winnipeg	Toronto	Total
Control	1,188,960	728,520	1,917,480
Monsanto	3,322,354	6,404,228	9,726,582
National	2,817,194	6,194,220	9,011,414
TOTAL	7,328,508	13,226,968	20,655,476

It is evident that the following relative device distance accumulations exist: Control 9.3%, Monsanto 47.1% and National 43.6%. This distribution is appropriate for the test, as the emphasis is placed on the new products, with the control device used as a baseline, and the bulk of the accumulation being split almost equally between the Monsanto and the National devices.

Observed Failures

For the purposes of this study, a device failure was defined as either the development of a visible crack in the base material or the material failure of a device resulting in its being lost. This definition excludes the deliberate removal of a device by the truck operator, damage in an accident, or failure of the flap mounting system itself, involving no visible damage to the flap.

A total of four failures was recorded during the test period. Table 3.13 below presents the relevant failure data.

TABLE 3.13

Device Failure Data

Item	Location	Date	Veh. Type	Device Type	Dist. To Failure (km)	Time To Failure (mo.)	Type of Failure
1.	Winnipeg	1/3/82	TR	M	97,880	2.25	Tractor front flap cracked
2.	Winnipeg	1/2/82	TR	N	43,450	2.00	One tractor rear flap broke off
3.	Winnipeg	22/2/82	TR	N	44,020	2.50	Tractor rear flap broke off
4.	Winnipeg	22/2/82	TR	N	44,020	2.50	Tractor rear flap broke off

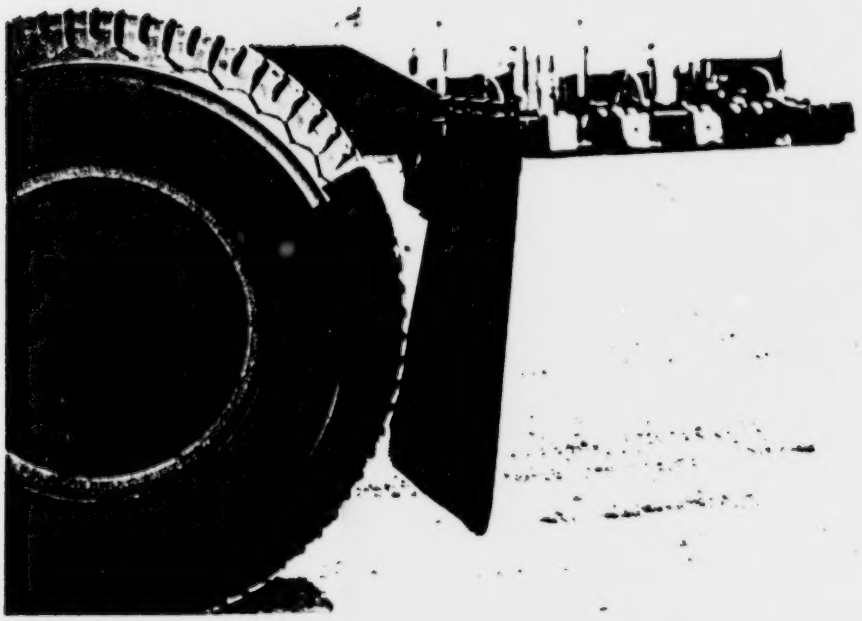
An examination of the data indicates that:

- all device failures occurred in Winnipeg, at Reimer Express, on tractors;
- three of the four failures were rear tandem devices;
- three of the four failures were National with one being Monsanto.

A further investigation indicated that all of the rear tandem mounted devices which failed were mounted on standard mounts, (See Figure 8). The type of failure on the rear tandem mounted devices was a crack in the material

FIGURE 8

Typical Mount on Reimer Vehicle



which resulted in the bulk of the device being lost during a trip. In the case of the front flap failure, Figure 9 (Reimer vehicle #5664) shows the crack which developed in the flap.

Flap Loading

The devices consist of monolithic sheets of either plastic or rubber material with a textured surface on the side facing the wheel. The upper edge of the device is attached to the vehicle by a metal bracket, permitting it to hang vertically behind the wheel in specific alignment with the wheel and the road surface. Typically, device dimensions are:

height	61 cm to 91 cm
width	46 cm to 61 cm
wheel clearance	15 to 20 cm
road clearance	23 cm

Mounting to the bracket is typically accomplished by four 9.5 mm mounting bolts tightened to a torque level of 16 Newton-metres. Plate washers or a metal strip are required to distribute the bolt tension into the device material without local overstressing.

Loads are applied to the devices by three primary mechanisms:

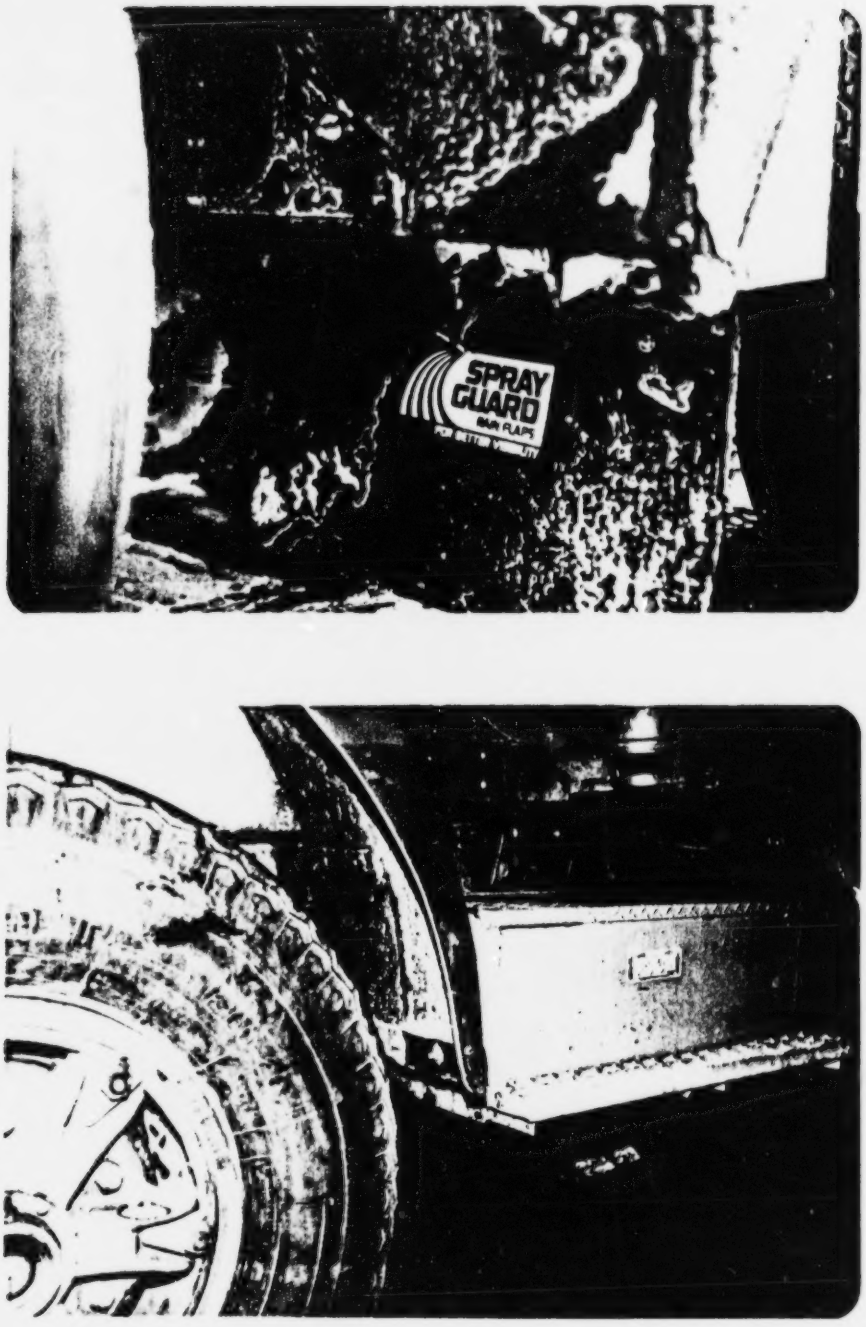
(1) The static weight of the flap applies a tensile load in the plane of the flap, with a maximum value at the bolt mounting holes.

(2) Combined aerodynamic and fluid mechanics forces cause the device to "sail" or deflect at speed, causing bending forces in the device, which are a maximum at the bolt mounting holes.

(3) The accumulation of snow/ice deposits increases the weight of the flap, and the tensile load described in (1) above. In addition, the displaced

FIGURE 9

Front Flap Failure



centre of gravity of the combined flap and deposits causes a bending movement in the device.

When the vehicle is in motion, the extreme vibration environment of the devices accentuates the magnitude of the loads, and causes load and stress reversals to take place within the devices. This results in the primary failure mechanism being fatigue related. The prediction of the failure point is made difficult even if the loading cycle is precisely know, as the properties of the material are both age and temperature dependent. A fatigue failure normally begins with a small crack, usually located at a discontinuity in the material, which causes a local stress concentration. Once the crack starts, it usually propagates quite rapidly decreasing the stressed area until the remaining area becomes overstressed and complete failure occurs.

Therefore, the normal failure mechanism for the devices is a fatigue failure which gives rise to a crack appearing in the highly stressed portion of the flap, near the bracket mounting points. Both aging of the plastic/rubber materials, and low ambient temperature, will lower the endurance limit of the devices, and failure is likely to occur particularly when heavy flap deposits increase the load on the devices.

Device Durability

For the purposes of this study, device durability will be construed as defined by mean distance to failure (MDTF) and/or mean time to failure (MTTF) from reliability analysis. Both parameters are useful as the life of the devices is both time dependent (through aging) and distance exposure dependent (through load cycles).

The small number of failures observed (four) in a total of 324 devices which accumulated a total of 20,655,476 kilometres over seven months, makes it difficult, if not impossible, to discern any differences in durability between the individual devices.

The mean time or distance between failures can be found by calculating the arithmetic average of the times to failure for a large number of device failures, if the test interval is four to five times longer than the mean time/distance between failure. Clearly that is not the case in this study. The test interval of seven months with maximum device exposures of up to 140,000 km is well below the mean time/distance between failures.

Methods do exist for predicting the mean time/distance to failure, given reasonably abbreviated test data. These methods involve the analysis of limited data against either an exponential or a Weibull reliability model. Due to the fact that no failure data were observed for the control devices, only one failure for 146 Monsanto devices, and three failures (two at the same elapsed distance and time) in the 144 National devices, insufficient data exist to compare the data to a given failure model.

The only conclusions that can be drawn regarding the durability of the devices, as measured by the mean time to failure or mean distance to failure are:

(1) The mean time to failure for the devices exceeds the seven month test period appreciably.

(2) The mean distance to failure, in the first seven months of age, exceeds 140,000 km appreciably.

(3) Although the National device failure rate is three times as large as the Monsanto device, both rates are too low to make valid comparisons between the durability of the various devices tested.

(4) The operating environment on the tractor, and particularly the rear tandems, appears to have a negative effect on device durability in

comparison to trailers, on which no device failures were reported. This may be due to flap vibration or to impacts of the devices occurring during hookup/drop operations.

Side Flaps

Trailer mounted side flaps were installed on several of the test vehicles, exclusive of the oil tankers, as indicated in Table 3.14.

TABLE 3.14

Number of Side Flaps Tested

Device Type	Winnipeg	Toronto	Total
Control	-	8	8
Monsanto	8	24	32
National	8	24	32
TOTAL	16	56	72

No failures whatsoever were experienced with the side flaps, and as they accumulated the same distance as the devices on the trailers to which they were attached, it can be concluded that the side flaps have a durability as great or greater than the flaps.

4.0 SUMMARY OF FINDINGS

This chapter provides a summary of the important findings of the project. It presents recommendations and conclusions emanating from these findings.

4.1 Summary of Findings

The findings can be grouped into information on snow and ice buildup, durability of the devices and the performance of the devices.

4.1.1 Buildup of Ice and Snow

The project has clearly discerned that buildup occurs on the test devices to a greater degree than it does on normal flaps. There is no appreciable difference between the quantity of buildup on National Rubber flaps or on Monsanto flaps both of which contain buildups of approximately three times the quantity observed on Control vehicles.

The largest buildups occur between the temperatures of 0°C and -10°C. Buildups were observed at much colder temperatures however. The number of days when these weather conditions occur during a year is relatively small.

Drivers report that the buildup can easily be removed in most cases.

There is no difference in the quantity of buildup on the left side or right side of the vehicle. Steering axle flaps because of their smaller area accumulate smaller buildups.

The use of salt on the roads does not seem to influence the quantity of buildup accumulated on the flaps.

Buildup will occasionally interfere with the efficient maintenance or operation of the vehicles.

4.1.2 Durability

Very few devices were observed to failure because of the short duration of the project. The only conclusions that can be drawn regarding the durability of the devices as measured by the mean time to failure or mean distance to failure are:

- the mean time to failure for the devices exceeds the seven month test period appreciably and the mean distance to failure in the first seven months of age exceeds 140,000 km appreciably;
- although the National device failure rate is three times as large as the Monsanto device, both rates are too low to make valid comparisons between the durability of the various devices tested;
- the operating environment on the tractor, and particularly the rear tandems, appears to have a negative effect on device durability in comparison to trailers on which no device failures were reported.

4.1.3 Performance

In Phase I of the project the literature search and review clearly revealed that superior performance would be expected from the new devices under warm wet weather conditions. This was confirmed by the interviews with drivers in the sample fleets.

Actual over-the-road testing could not be accomplished within this project because of a number of difficulties. The opinions of drivers taking part in the survey were solicited. Their comments indicate that the flaps are accepted as a definite improvement over standard flaps and operate acceptably under cold weather conditions.

4.2 Peripheral Findings

In addition to the main objectives of the project a number of operational problems were revealed during the project through both the survey designed for this project and the telephone interviews undertaken as part of the work.

- Because of the greater mass of the flaps, the greater rigidity and the greater possibility of buildup it is necessary to have heavy duty brackets for the devices. Companies installing the new flaps should be made aware that special brackets should be installed to avoid the problem of bracket failure.

- Mud buildup under summer conditions can cause a problem similar to the buildup of snow and ice. The higher density of mud results in an even greater mass hanging from the bracket. If secondary roads are to be travelled a strengthening of the mounting system must also be considered.

- A number of specific operational considerations must be considered when installing the flaps. The flaps are larger and stiffer than conventional flaps and can interfere with cab-over maintenance. The side flaps can also interfere with pins used to secure sliding bogies on trailers. These skirts can also interfere with the changing of tires.

- The buildup can interfere with access to valves on some tankers.

- The flaps require a greater cost because of initial capital costs, longer time to install the devices, and greater cleaning time during the winter period.

4.3 Conclusions

The major conclusions of the project are as follows:

- Greater buildup of ice, snow (and potentially mud) will be encountered using the test devices.

- Stronger brackets will be required for mounting of these devices.

- Performance of the devices is as good or better than standard flaps.

- Greater costs will be associated with the installation of these devices either as retrofit or as original equipment.

- Durability of the devices appears to have been improved through the introduction of New Series by Monsanto. National Rubber devices appear to be quite durable. A detailed estimate of the time to failure cannot be made based upon the limited observational data obtained in this project. It is estimated that at least one additional year's observational data would be required to establish the life cycle.

APPENDIX A

Data Collection Instructions

APPENDIX A
Data Collection Instructions

Included in Appendix A are the data forms and instructions used during the course of the study. The appendix has been subdivided into 5 parts which include:

Part I: Vehicle description sheets

Part II: Flap Buildup instructions

Part III: Terminal Invesigation data sheets

Part IV: Over the road test instructions and data sheets

Part V: Fleet responsibilities instructions

PART I

VEHICLE
DESCRIPTION
SHEETS

TRACTOR DATA SHEET – TEST/CONTROL DATE _____

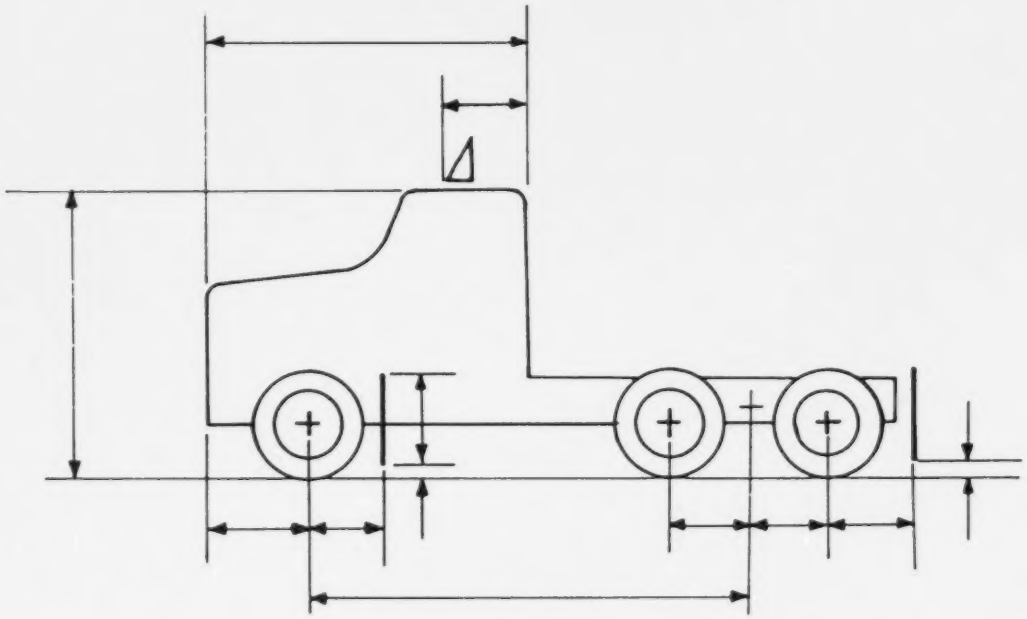
OWNER: _____ LICENCE PLATE NO. _____ PHOTOS: ROLL.NO. _____
FRAMES. _____

CONFIG./DESCRIP. _____

ODOMETER READING: START _____ DATE _____; FINISH _____ DATE _____

IDENT.NO _____ TYPE _____ MAKE _____ MODEL _____ NO.OF AXLES _____ WIDTH _____

TRAILER IDENT.NO _____



FLAPS – TYPE: _____ _____
MOUNT: _____ _____
MAKE: _____ _____

TIRES – MAKE: _____ _____
SIZE: _____ _____
TREAD DEPTH: _____ _____

FENDERS-TYPE: _____

BRACKET TYPE: _____

TRACTOR DATA SHEET – TEST/CONTROL DATE _____

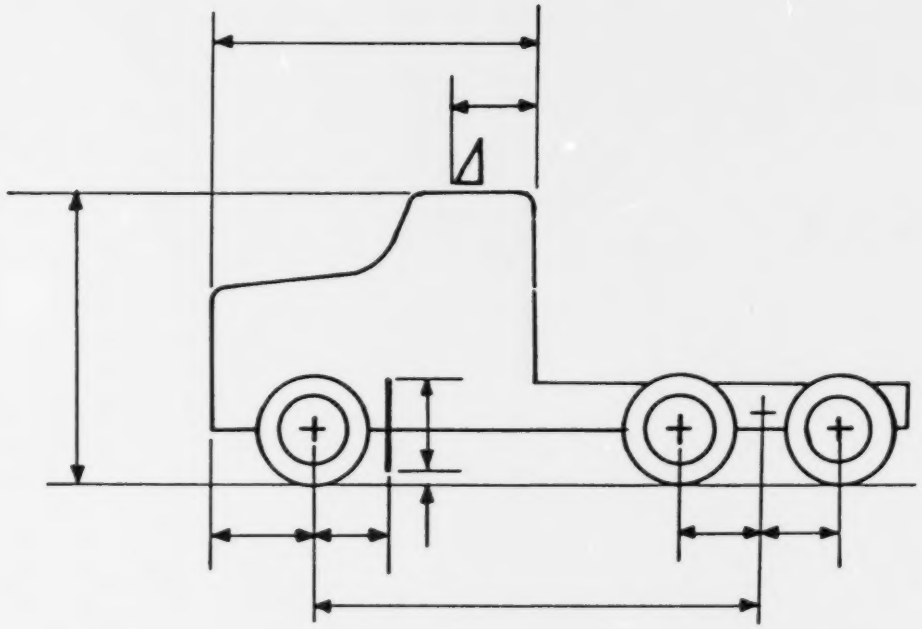
OWNER: _____ LICENCE PLATE NO. _____ PHOTOS: ROLL.NO. _____
FRAMES. _____

CONFIG./DESCRIP. _____

ODOMETER READING: START _____ DATE _____; FINISH _____ DATE _____

IDENT.NO _____ TYPE _____ MAKE _____ MODEL ____ NO.OF AXLES _____ WIDTH _____

TRAILER IDENT.NO _____



FLAPS – TYPE: _____ _____
MOUNT: _____ _____
MAKE: _____ _____

TIRES – MAKE: _____ _____
SIZE: _____ _____
TREAD DEPTH: _____ _____

FENDERS-TYPE: _____

BRACKET TYPE: _____

TRACTOR DATA SHEET — TEST/CONTROL DATE _____

OWNER: _____ LICENCE PLATE NO. _____ PHOTOS: ROLL NO. _____

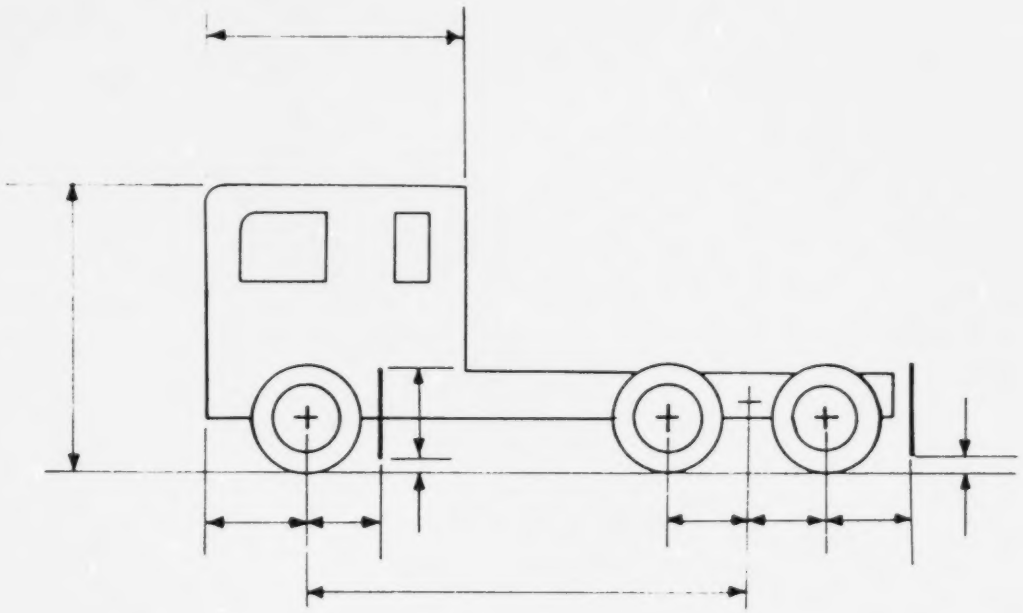
FRAMES _____

CONFIG./DESCRIP. _____

ODOMETER READING: START _____ DATE _____ ; FINISH _____ DATE _____

IDENT.NO _____ TYPE _____ MAKE _____ MODEL _____ NO. OF AXLES _____ WIDTH _____

TRAILER IDENT.NO _____



FLAPS — TYPE: _____ _____
MOUNT: _____ _____
MAKE: _____ _____

TIRES — MAKE _____ _____
SIZE: _____ _____
TREAD DESIGN _____ _____

FENDERS - TYPE: _____

BRACKET TYPE: _____

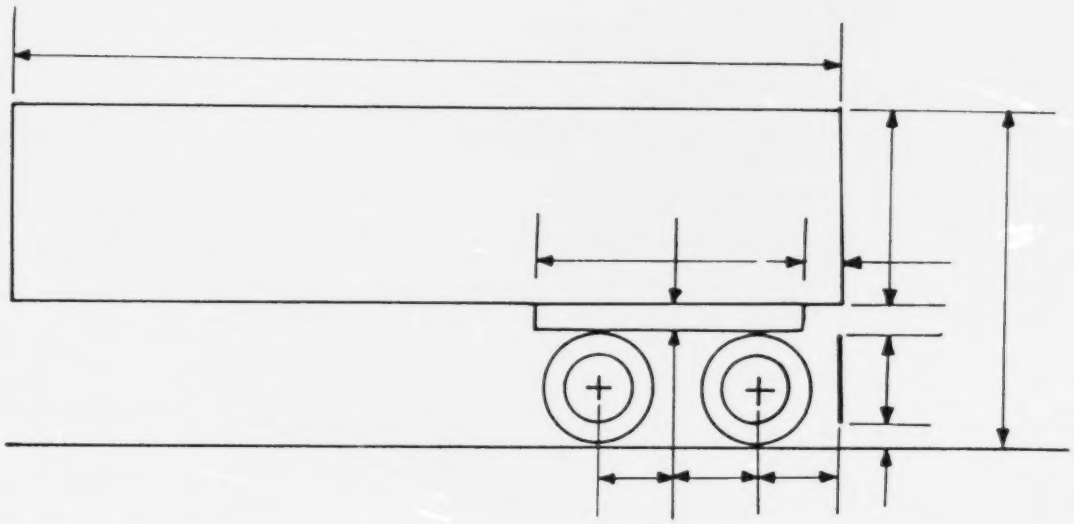
TRAILER DATA SHEET – TEST/CONTROL DATE _____

OWNER: _____ LICENCE PLATE NO. _____ PHOTOS: ROLL NO. _____
FRAMES _____

CONFIG./DESCRIP. _____

IDENT.NO _____ TYPE _____ MAKE _____ MODEL _____ NO.OF AXLES _____ WIDTH _____

TRACTOR IDENT.NO. _____



BACK FLAPS — TYPE: _____
MOUNT: _____
MAKE: _____

SIDE FLAPS — TYPE: _____
MAKE: _____

TIRES — MAKE: _____
SIZE: _____
TREAD DEPTH: _____

FENDERS-TYPE: _____

BRACKET TYPE: _____

TRAILER DATA SHEET – TEST/CONTROL

DATE _____

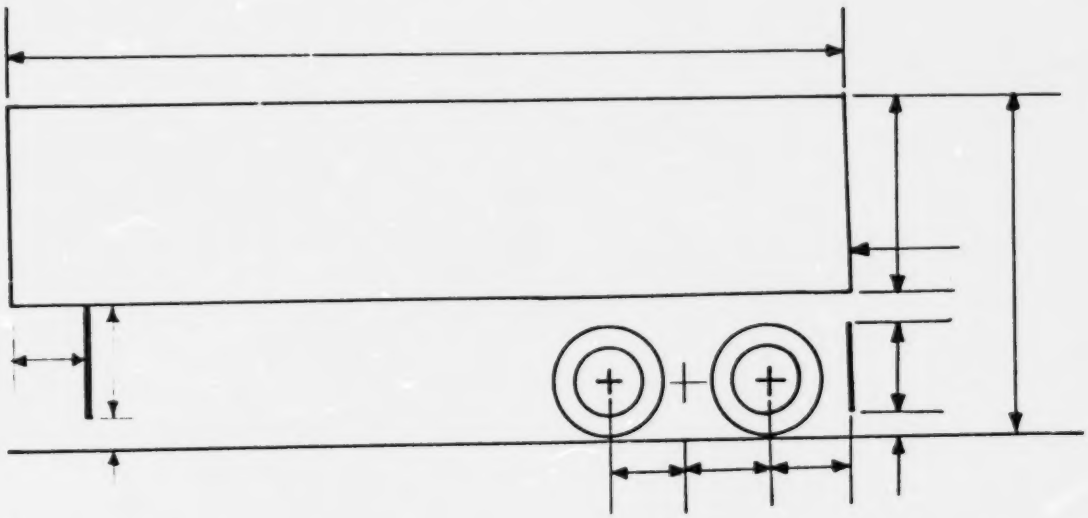
OWNER: _____ LICENCE PLATE NO. _____ PHOTOS: ROLL NO. _____

FRAMES _____

CONFIG./DESCRIP. _____

IDENT.NO _____ TYPE _____ MAKE _____ MODEL _____ NO.OF AXLES _____ WIDTH _____

TRACTOR IDENT.NO. _____



BACK FLAPS
- TYPE: _____
- MOUNT: _____
- MAKE: _____

SIDE FLAPS
- TYPE: _____
- MAKE: _____

TIRES
- MAKE: _____
- SIZE: _____
- TREAD DEPTH: _____

FENDERS-TYPE: _____

BRACKET TYPE: _____

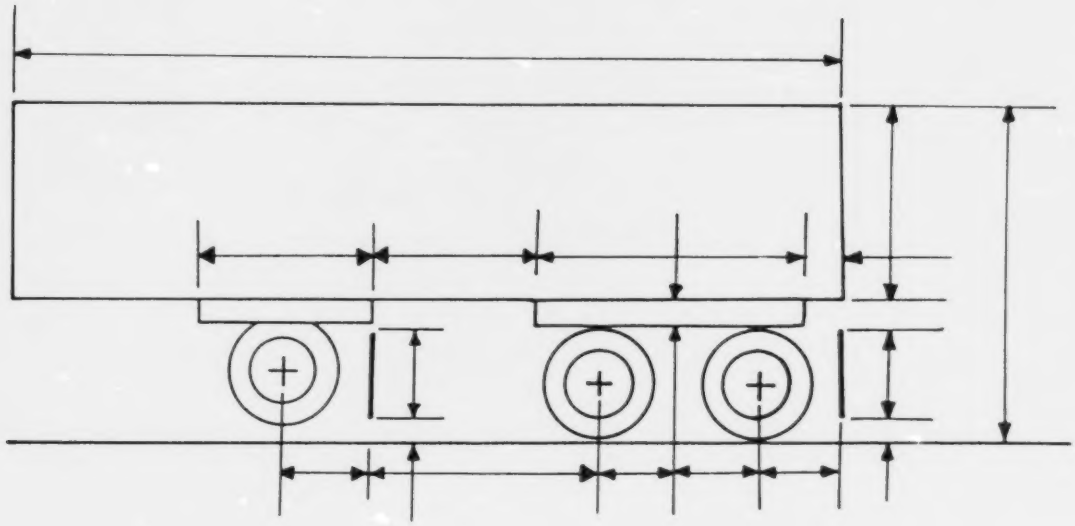
TRAILER DATA SHEET – TEST/CONTROL DATE _____

OWNER: _____ LICENCE PLATE NO. _____ PHOTOS: ROLL NO. _____
FRAMES _____

CONFIG./DESCRIP. _____

IDENT.NO _____ TYPE _____ MAKE _____ MODEL _____ NO.OF AXLES _____ WIDTH _____

TRACTOR IDENT.NO. _____



BACK FLAPS
- TYPE: _____
- MOUNT: _____
- MAKE: _____

SIDE FLAPS
- TYPE: _____
- MAKE: _____

TIRES
- MAKE: _____
- SIZE: _____
- TREAD DEPTH: _____

FENDERS-TYPE: _____

BRACKET TYPE: _____

TRAILER DATA SHEET – TEST/CONTROL

DATE _____

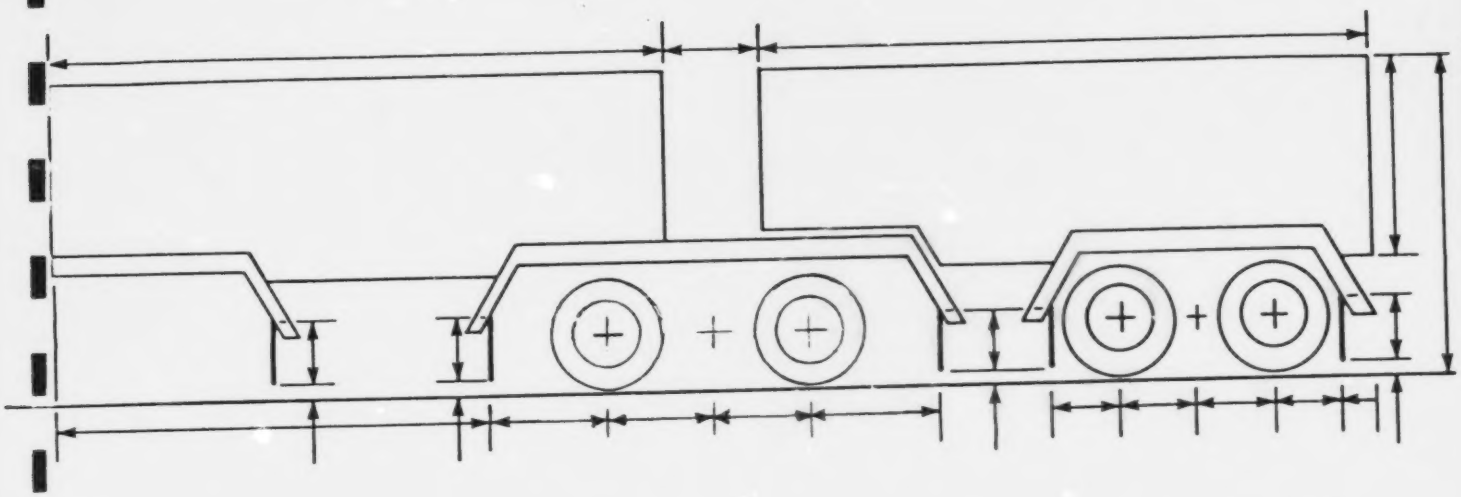
OWNER: _____ LICENCE PLATE NO. _____ PHOTOS: ROLL NO. _____

FRAMES _____

CONFIG./DESCRIP. _____

IDENT.NO _____ TYPE _____ MAKE _____ MODEL _____ NO.OF AXLES _____ WIDTH _____

TRACTOR IDENT.NO. _____



BACK FLAPS
- TYPE: _____
- MOUNT: _____
- MAKE: _____

SIDE FLAPS
- TYPE: _____
- MAKE: _____

TIRES
- MAKE: _____
- SIZE: _____
- TREAD DEPTH: _____

FENDERS-TYPE: _____

BRACKET TYPE: _____

TRAILER DATA SHEET – TEST/CONTROL

DATE _____

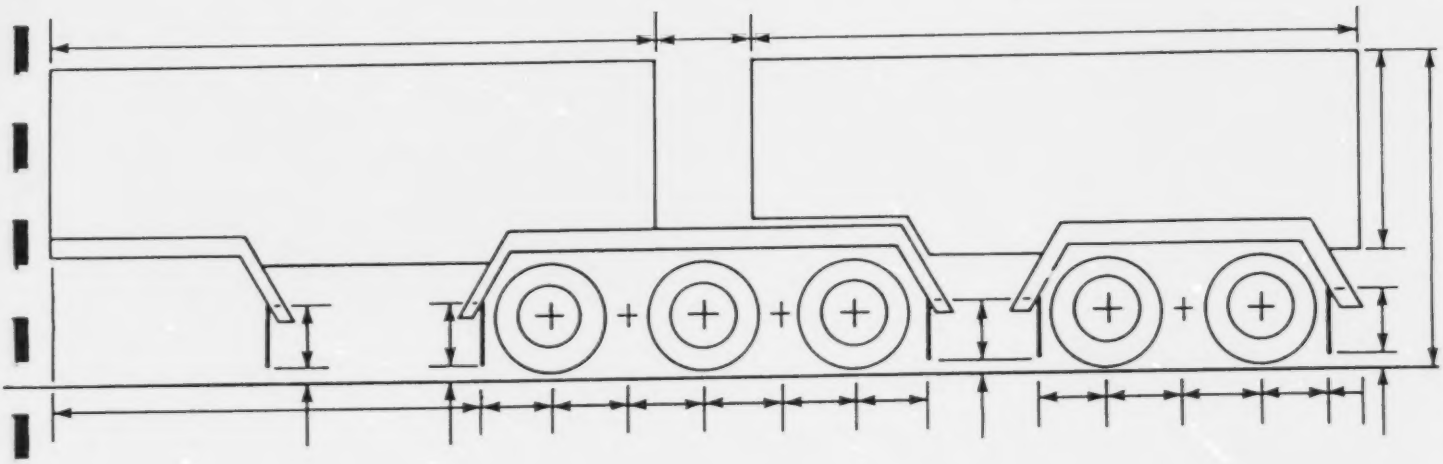
OWNER: _____ LICENCE PLATE NO. _____ PHOTOS: ROLL NO. _____

FRAMES _____

CONFIG./DESCRIP. _____

IDENT.NO _____ TYPE _____ MAKE _____ MODEL _____ NO.OF AXLES _____ WIDTH _____

TRACTOR IDENT.NO. _____



BACK FLAPS
- TYPE: _____
- MOUNT: _____
- MAKE: _____

SIDE FLAPS
- TYPE: _____
- MAKE: _____

TIRES
- MAKE: _____
- SIZE: _____
- TREAD DEPTH: _____

FENDERS-TYPE: _____

BRACKET TYPE: _____

PART II

FLAP BUILDUP

- PHOTOGRAPHER'S INSTRUCTIONS
- PHOTO IDENTIFICATION CODE

SNOW BUILDUP ON FLAPS

Photographer's Instructions

Date _____ Time _____ Location _____

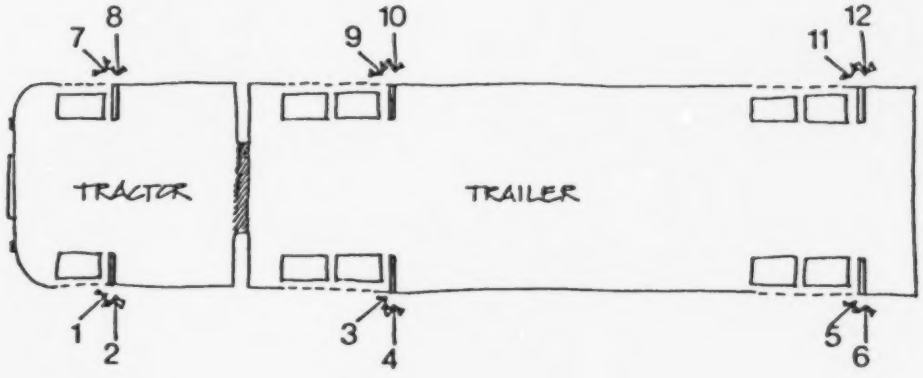
Weather _____ Temperature _____

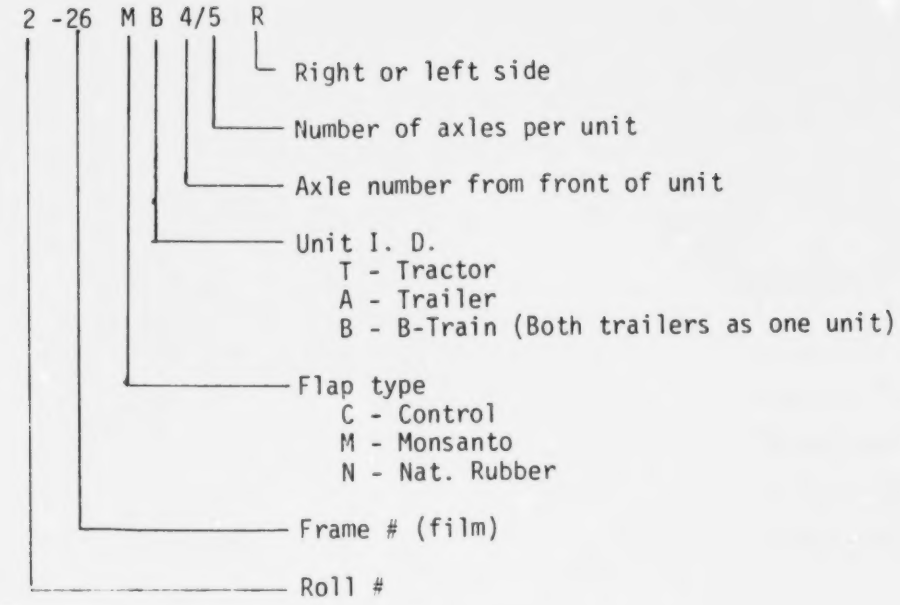
Camera _____ Lens _____ Shutter Speed _____

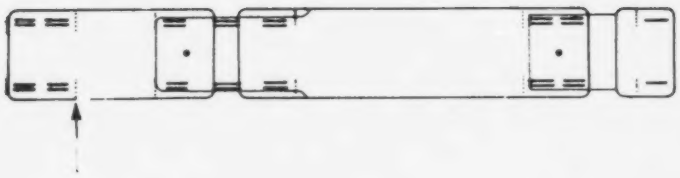
Apperture _____ Flash _____ Film _____ Photographs _____

- Photos to be taken in sequence shown; if possible take a top view photo of flap;
- Additional photos may be required for different truck configuration, (triaxles, tankers, etc.). Photograph left side of truck, front to back, and then right side, front to back;
- Oblique shot of each flap so that snow buildup is just visible past tire; tire should fill the viewfinder;
- Profile shots, have camera level; tire should fill viewfinder;
- Flash likely required in sun;
- Use flash on manual;
- Have flash directly over lens;
- If flash used outdoors set flash @ 1 stop less than existing light. Set flash distance different than camera if required;
- Spot focus;
- Watch camera synchronization speed;
- If camera gets cold, warm up gradually (i.e., in case);
- Electronic camera may totally fail if battery gets too cold, carry spare in pocket. Ditto flash;
- Hold camera steady for slow flash synchronization speeds.

PHOTO SEQUENCE:







Therefore above Photo I.D. would represent as marked.

PART III

TERMINAL INVESTIGATION

- DRIVER INTERVIEW
- DETAILED FLAP BUILUP DESCRIPTION
- FLAP FAILURE OR DAMAGE

FORM 1

DRIVER INTERVIEW SHEET

Fleet _____ Type of Flaps _____

Date _____ Time _____ Location _____

Tractor I.D. No. _____ Mileage _____

Trailer I.D. No. _____ Mileage _____

Trip Origin _____ Date _____ Time _____

Highway Used _____ Stop Made _____

Average Speed _____

WEATHER CONDITION

Precipitation Type _____ Intensity _____

Temperature _____ Wind Magnitude and Direction _____

Other _____

ROAD CONDITION

Surface Accumulation _____ Type _____

Ploughed? _____ Salted? _____

FLAP PERFORMANCE

. Any flap build-up observed? _____

If yes - build-up accumulation _____

- type of build-up _____
- flap location _____
- did any of the build-up fall off before reaching your destination? _____
- is the visibility, better/same/worse, than if no build-up was present? _____

. How would you compare the performance of these flaps to other flaps?

_____

_____

. Other comments _____

_____

_____

_____

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet _____ Type of Flaps _____

Date _____ Time _____ Location _____

Tractor I.D. No. _____ Mileage _____

Trailer I.D. No. _____ Mileage _____

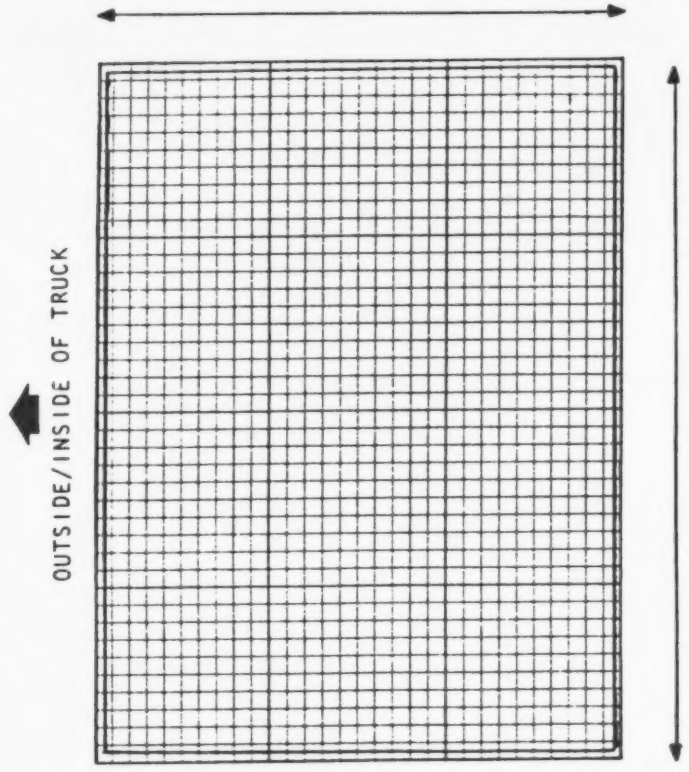
B. Flap Location _____

Type of build-up _____

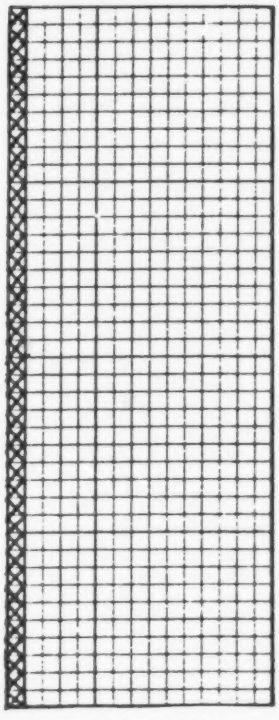
Accumulation _____

Any damage to flap _____ If so, fill out Form 3.

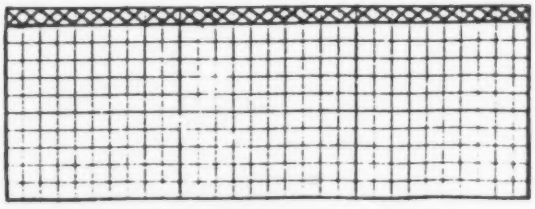
Photos No. _____ _____ _____



PLAN VIEW



SIDE VIEW



TOP VIEW

NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

FORM 3

FLAP FAILURE OR DAMAGE SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet _____ Type of Flaps _____

Date _____ Time _____ Location _____

Tractor I.D. No. _____ Mileage _____

Trailer I.D. No. _____ Mileage _____

B. Flap Location _____

Damage to Flap _____

Work Performed _____

Cause of Damage or Failure _____

_____

_____

_____

C. Other Comments _____

_____

_____

_____

PART IV

OVER THE ROAD TEST

. DESCRIPTION SHEET
. PHOTOGRAPHER'S INSTRUCTIONS

OVER-THE-ROAD TEST

Date _____ Time _____ Test No. _____

Location _____

Temperature _____ Wind Magnitude and Direction _____

Precipitation Type and Intensity _____

Depth of Snow on Road _____ Sky Condition _____

Pavement Type _____ Condition _____

Camera Type _____ Film Type _____

VARIABLE	OBSERVATION NUMBER				
Camera Lens Shutter Speed f Stop Filter Meter - Auto - Manual Shots/Second No. of Shots Film No. Truck No. Truck Description Truck Speed Lead Car Type Chase Car Type Lead Car Location Chase Car Location Passing Speed Wiper Location in Picture Radio Contact Truck Spray Cloud Flap Deposit Broken Flap					

OVER-THE-ROAD TEST
Photographer's Instructions

A) Photos from Chase Car

- take pictures from front passenger seat
- use motor drive not power winder
- take picture from a distance of approximately 140 feet behind the truck until truck has been passed
- use circle in viewfinder to set distance to truck at 140 feet
- picture should show hood and pillar
- keep camera in a fixed position; do not follow truck
- use wiper blade as timer (fast speed)
- have wiper at the left in each shot
- use CG film
- use polarizing filter in sun
- use 1/500 as minimum speed
- use incident metering in snow

B) Photos from Truck Cab

- take pictures from passenger seat using both left and right side mirrors
- take 3 shots of passing vehicle as vehicle being passed
  i) when car fills first half of mirror
  ii) when car fills the mirror
  iii) when car fills last half of mirror
- spot meter in mirror
- focus at
- minimum speed 1/500
- use CG film

PART V

FLEET RESPONSIBILITIES

DeLCan
DE LEUW CATHER CANADA LTD
CONSULTING ENGINEERS AND PLANNERS

EVALUATION OF SPLASH AND SPRAY ALLEVIATION DEVICES
FLEET RESPONSIBILITIES

- Notify DeLCan staff if any snow or ice build-up is observed on the flaps of any test vehicle as it returns to the terminal. DeLCan will immediately respond by either visiting the terminal to take some photographs of the flaps and obtain some comments from the driver or they will simply record the call along with some information regarding the build-up.

- Notify DeLCan staff immediately if a flap failure occurs (i.e. cracking, rip, fallen off). The odometer reading should be recorded at the time of failure. The damaged flap will be replaced with a new flap.

- When possible, observations may be performed at a weigh scale station as the vehicles enter the station on their normal run. The personnel at the weigh scale would notify DeLCan staff of any occurrence of build-up on any vehicle. DeLCan would then determine if a test vehicle is scheduled to run through the station and the approximate time. A DeLCan investigator would then proceed to the weigh scale and wait for the test vehicle to arrive, at which time photographs of the vehicle would be taken.

The person to contact at DeLCan is:

Mr. Rob Cooper
441-4111

DE LEUW CATHER CANADA LTD · 133 WYNFORD DRIVE, DON MILLS ONTARIO M3C 1K1
(416) 441-4111 · CABLE DELCAN, TORONTO TELEX 06-9666-89
OFFICES ST JOHN'S MONTREAL OTTAWA HAMILTON NIAGARA FALLS KITCHENER LONDON
THUNDER BAY WINNIPEG REGINA SASKATOON EDMONTON CALGARY VANCOUVER

APPENDIX B

Telephone Survey of Flap Performance and Durability

APPENDIX B

Telephone Survey of Flap Performance and Durability

Fleet: MacMillan Bloedel, Pembroke

Type of flap: Monsanto

Initial contact date: August 27, 1981

Comments:

The company initially purchased the flaps late in the fall of 1980. Seven trucks and ten trailers were equipped with the new flaps. No side skirts were installed on the trailers.

At the time the contact was made, all flaps had been replaced due to cracking failures over the winter months. Most failures occurred as a result of driver kicking the flaps to remove excess buildup.

All damaged flaps were replaced with the same type of flaps and were still on the vehicles at the time of contact.

The driver comments were generally positive. They observed a reduction in splash and spray and the rear visibility is improved. The snow and ice accumulation was greater than standard flaps but they had no problem in removing the buildup by kicking the flap.

Final contact date: June 22, 1982

Comments:

The company no longer own the vehicles; they are all leased in a broker type operation. The second set of flaps installed on the vehicles also failed over the winter months. New Monsanto flaps were provided but were not installed on most of the vehicles since standard flaps had already been mounted.

Only one vehicle still has the Monsanto flaps and has gone through the winter months with no failures. The driver commented that the snow accumulation was greater than standard flaps, but could easily be removed by kicking the flap. The splash and spray did not seem to be any worse than the standard flaps when buildup was present. The driver of the vehicle reported that he prefers the Monsanto flap over the standard flap.

Fleet: Carling O'Keefe, Mississauga

Type of flap: National Rubber

Initial contact date: August 26, 1981

Comments:

The fleet consists of 62 vehicles of which 5 tractors have been equipped with the National Rubber flaps. No trailer installations at the time of contact. The devices had been installed approximately six months earlier and had not been through winter conditions yet. All flaps were mounted on a rigid type bracket. No failures had been reported to date.

The driver comments were positive. They preferred this type of flap over the standard flap because the splash and spray was reduced, and the rear visibility was improved. They did not find any difference in the cleanliness of the vehicles using the National Rubber flaps. Mud accumulation did not present any problems.

Final contact date: June 22, 1982

Comments:

Five more vehicles (tractor and trailers) have been equipped with the National Rubber flaps. No side skirts have been installed. All National Rubber installations to date have reported no failures or problems. Buildup did not seem to be a problem over the winter months. The driver comments were generally the same as the initial contact with the fleet. They hope to convert all their fleet to National Rubber flaps.

Fleet: Coca-Cola, Toronto

Type of flap: National Rubber

Initial contact date: August 26, 1981

Comments:

The total fleet consists of 37 vehicles of which only a few (2 or 3) are equipped with the National Rubber flaps. The flaps were purchased less than two months prior to this contact. National Rubber flaps are installed on the vehicles as the old standard flaps are worn off. They do not have the side skirts installed on their vehicles.

During the short period of time since the flaps were installed, no failures have been reported. The drivers reported an excellent performance. Splash and spray was significantly reduced using these flaps. The company hopes to eventually equip all their vehicles with the devices.

Final contact date: June 22, 1981

Comments:

Since the last contact, all vehicles have been transferred over to another department. The contact reported that none of his vehicles were equipped with National Rubber flaps. All vehicles transferred over were equipped with standard flaps and still are. They have no intention of converting to National Rubber or Monsanto flaps.

Fleet: Bulk Carriers, Toronto

Type of flap: National Rubber and Monsanto

Initial contact date: August 27, 1981

Comments:

All flaps were purchased 3 or 4 months prior to contact. Four vehicles were equipped with the National Rubber flaps and five with the Monsanto flaps. None of the vehicles have side skirts installed. Their vehicles have fenders which partially enclose the wheels of the vehicle, acting the same way as a side skirt would, thus they see no potential improvement in using the skirts. According to head office, some Monsanto flaps were replaced due to failures although this could not be confirmed with the terminal managers in Toronto and Montreal since they had not been monitoring the performance or durability of the flaps. They were asked to monitor the performance over the winter months and that we would contact them at a later date.

Final contact date: June 22, 1982

Comments:

No other Monsanto or National Rubber flaps have been installed since the last contact. The drivers have reported no significant improvement using the new devices. The splash and spray seems to be the same as the standard flaps and the buildup is no worse. No failures have been reported with either types of flaps. The drivers have no preference for one flap over the other.

The main reason for not converting their whole fleet to the National Rubber or Monsanto flaps is the cost of the devices, which in their opinion is not justifiable by their performance.

Fleet: Shell Oil, London

Type of flap: National Rubber and Monsanto

Initial contact date: August 27, 1981

Comments:

One tanker was equipped with Monsanto flaps including side skirts in August 1980 upon a request by Monsanto as a trial. The flaps were removed in December 1980 because of cracking failures. They were replaced with National Rubber flaps at that time and were still on the vehicle at the time the contact was made.

Monsanto requested another trial using another vehicle. The flaps were installed in January 1981. Two or three of those flaps still remained on the vehicle at the time of contact. The others had fallen off.

Despite the poor durability obtained from the Monsanto flaps, they felt their performance ws superior to that of the National Rubber flaps in reducing splash and spray. Both types of flaps did accumulate more snow and ice than the standard flaps.

Final contact date: June 23, 1982

Comments:

The fleet still have one Monsanto and one National Rubber equipped vehicle. The Monsanto vehicle was equipped last fall with Monsanto's "3rd generation flap". No failures were reported over the winter months on both types of flaps. The drivers commented that they prefer the Monsanto flaps over the National Rubber and standard flaps because they are more effective in reducing the splash and spray. They also commented that they did not like the appearance of the side skirts and the way they were mounted on the vehicles (i.e. holes drilled in the fenders). The company is considering redesigning their fenders to better accommodate the side skirts on the vehicles. They would like to eventually convert all their fleet to Monsanto flaps once a solution has been found for the side skirt appearance and mounting.

Fleet: Consumers Distribution, Mississauga

Type of flap: National Rubber and Monsanto

Initial contact date: August 28, 1981

Comments:

Their total fleet consists of 36 power units and 100 trailers of which 6 tractors and 6 trailers are equipped with Monsanto flaps and 3 tractors and 3 trailers with National Rubber flaps. Side skirts were not installed with either type of flaps. The Monsanto flaps were initially installed in the fall of 1980 and have all failed due to cracking after two months of service. These were replaced with standard flaps for the remainder of the winter months. The National Rubber flaps were only installed in July 1981, therefore their durability could not be assessed at the time of contact.

The driver comments were generally positive. They preferred the Monsanto and National Rubber flaps over the standard flaps because they were more effective in reducing the splash and spray.

The company would like to convert most of their fleet to the Monsanto or National Rubber flaps when a more durable flap can be manufactured.

Final contact date: June 23, 1982

Comments:

The company is still experiencing problems with both types of flaps. Excessive snow and ice buildup causes the flaps to tear or crack. They have experimented with different types of brackets and are now using the joining coil type of bracket. The flaps usually crack or tear off at the mounting bolts.

They now have approximately 70% of their fleet equipped with the Monsanto and National Rubber flaps with the majority being National Rubber flaps because of the slightly better performance and lower cost. The reason they are still using these flaps is because they like to show a good image to the public.

The drivers seem to be in favour of the flaps because they reduce the splash and spray which improves the rear view visibility and helps to keep the side mirrors clearer. They would like to see a more durable flap.

Fleet: Simpsons, Toronto

Type of flap: National Rubber and Monsanto

Initial contact date: August 28, 1981

Comments:

The company has equipped 28 vehicles with Monsanto devices (mostly single units), and 3 with National Rubber devices. Only one National Rubber vehicle is equipped with the side skirts.

The Monsanto flaps were purchased in March or April of 1981 and some failures have been experienced due to cracking. The National Rubber flaps were purchased shortly after and no failures were reported at the time of contact.

The type of bracket used is a flexible type. Modifications were done to the bracket mounting in order to distribute the stress on the flaps. Since then no failures have been reported.

The general impression from the drivers is that the Monsanto and National Rubber flaps are better at reducing splash and spray than standard flaps.

The flaps still have to be tested for durability under snow and ice buildup conditions.

Final contact date: June 23, 1982

Comments:

The company now has 40 Monsanto equipped single unit trucks and 12 National Rubber vehicles, one of them having the side skirts.

They have experienced problems with the Monsanto flaps during the winter months. Excessive buildup would cause the flaps to crack at the mounting bolts for those flaps installed on the spring type bracket. Those mounted on on a rigid type bracket did not experience any failures. No failures were reported with the National Rubber flaps since their installation.

The drivers are in favour of the Monsanto and National Rubber flaps because of their performance and also create good public relations. They expressed some concern about the excessive buildup on the flaps which constantly had to be removed by kicking the flap. The vehicles seemed cleaner when these flaps were used.

All new vehicles purchased will be equipped with the Monsanto or the National Rubber flaps.

APPENDIX C

Description of Survey Fleets

LABATTS BREWERIES

Labatts Breweries has a total of 60 tractors and 90 trailers operating from two terminals in Toronto and London, Ontario. The largest portion of their vehicles are tri-axle dry vans with a few tandem axle vehicles used for city operations only. The Toronto terminal was selected and 48 trailers and 33 tractors are based at that location. All tractors have spring-mounted brackets and all trailers have rigid brackets. Because they are using a constant load the trailer bogies are fixed.

Labatts does not normally run with a dedicated tractor-trailer combination, but they were able to dedicate them for the period of this project.

Their service area includes a great number of routes primarily to the north and east from the Toronto depot. The north routes go as far as Nipigon and Timmins while the east routes go as far as the Quebec border.

MOLSON BREWERY

Molson Brewery has 60 tractors and 80 trailers operating from two terminals in Ontario at Toronto and at Barrie. The trailers are 40 and 45 foot vans with both tandem and tri-axle configurations. All trailers were equipped with hub odometers and because of the constant payload there are no sliding bogies. Approximately 30 tractors and 40 trailers are located at each of the terminals. All tractors have spring-mounted brackets and trailers have both rigid and flexible bracket types.

The vehicles are not dedicated for normal operation, however Molson's were able to arrange for the study vehicles to be dedicated over the course of the study.

Vehicles operating out of Toronto go east as far as the Quebec border and west as far as St. Catharines and Niagara Falls. Out of Barrie the vehicles travel north as far as Thunder Bay, Timmins and Nipigon and west as far as Windsor and Sarnia. Most vehicles return to home base in the same day.

IMPERIAL OIL

Imperial Oil operates across Canada from five regions. In total they have 200 power units and 400 trailers mostly operating in B-train configurations. The Toronto/Finch Station was selected for the Ontario base and has 14 B-trains operating.

There are many types of tractors in operation and a variety of trailer manufacturers supplying the company. Tractor-trailer combinations are fully dedicated and are only separated when necessary to affect repairs. All trailers have hub odometers. Almost all flaps are frame mounted.

All vehicles operating from either the Toronto or Winnipeg depot can return to home base by the end of the work day.

REIMER EXPRESS

Reimer Express is a 'for-hire' carrier operating from coast-to-coast in Canada. The company operates approximately 300 tractors and 700 trailers company wide with their headquarters located in Winnipeg. None of their vehicles are dedicated and thus the trailers can be anywhere in Canada at any given time. The tractors usually operate the same route on a continuous basis. Tractors are generally exposed to the same environmental conditions for their full life. The company operates vans only with fixed bogie configurations. Fixed brackets are used on both the tractors and trailers.

TROJAN FREIGHT

Trojan Freight operates a general freight service between Toronto and the Maritime provinces. Only one vehicle is operated on this route and is operated by a broker. The vehicle is based in Toronto but operates on a continuous basis between the two destination points.

KINGSWAY TRANSPORT

Kingsway Transport is a 'for hire' carrier operating primarily in Ontario and Quebec. None of the vehicles are 'married' and thus the combinations were not maintained for the study. Kingsway participated in the project from Ottawa-Montreal in the first phase and Toronto in the second phase. The equipment used is conventional tractors with dry vans carrying general freight.

APPENDIX D

TYPICAL BUILD-UP DATA

NATIONAL RUBBER VEHICLE

FORM 1

DRIVER INTERVIEW SHEET

Fleet Reimer Express
Type of Flaps National Rubber
Date Feb. 8/82 Time 1:00 P.M. Location Winnipeg, man.
Tractor I.D. No. 5666 Mileage 187,199 K.m.
Trailer I.D. No. _____ Mileage _____

Trip Origin Winnipeg, man. Date Feb. 3 Time 1:00 A.m.
Highway Used #16 west Stop Made Edmonton
Average Speed 90 K.m.h.

WEATHER CONDITION

Precipitation Type Snow Intensity Very light
Temperature -20° - -30°c Wind Magnitude and Direction S.W. 10 K.m.h.
Other Nil

ROAD CONDITION

Surface Accumulation Nil Type Nil
Ploughed? 100% Salted? No

FLAP PERFORMANCE

. Any flap build-up observed? ___ yes
If yes - build-up accumulation very little
- type of build-up snow
- flap location Behind Front and Rear wheels
- did any of the build-up fall off before reaching your destination? No
- is the visibility, better/same/worse, than if no build-up was present? Better

. How would you compare the performance of these flaps to other flaps?
Better

. Other comments The mirrors and side windows stay much cleaner in wet conditions.

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express ..... Type of Flaps {Conventional} National Rubber

Date Feb. 8/82 Time 10:45 A.m. Location Winnipeg, Man.

Tractor I.D. No. 5666 Mileage 187,199 K.m.

Trailer I.D. No. _____ Mileage _____

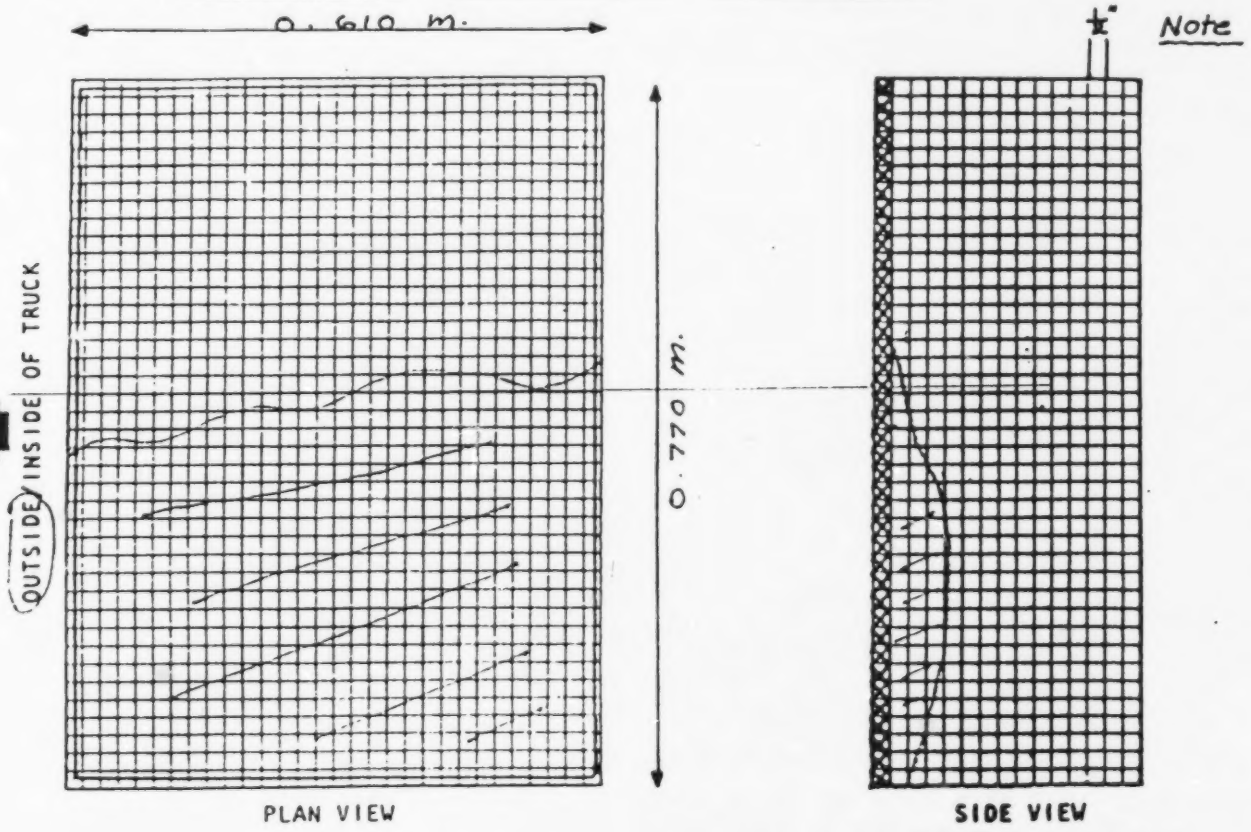
B. Flap Location Passenger Side - Behind Rear Wheels

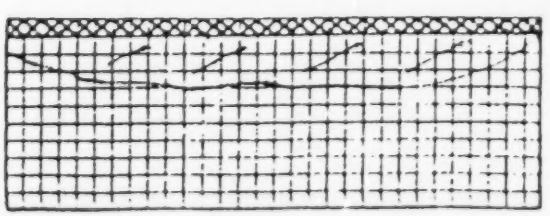
Type of build-up Ice and Snow

Accumulation Light - 1/4" (35 m.m.)

Any damage to flap yes If so, fill out Form 3. {Replaced}

Photos No. Roll # 13 - 1 2 3





TOP VIEW

NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2 INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps National Rubber

Date Feb. 8/82 Time 10:45 A.m. Location Winnipeg, man.

Tractor I.D. No. 56666 Mileage 187,189 K.m.

Trailer I.D. No. _____ Mileage _____

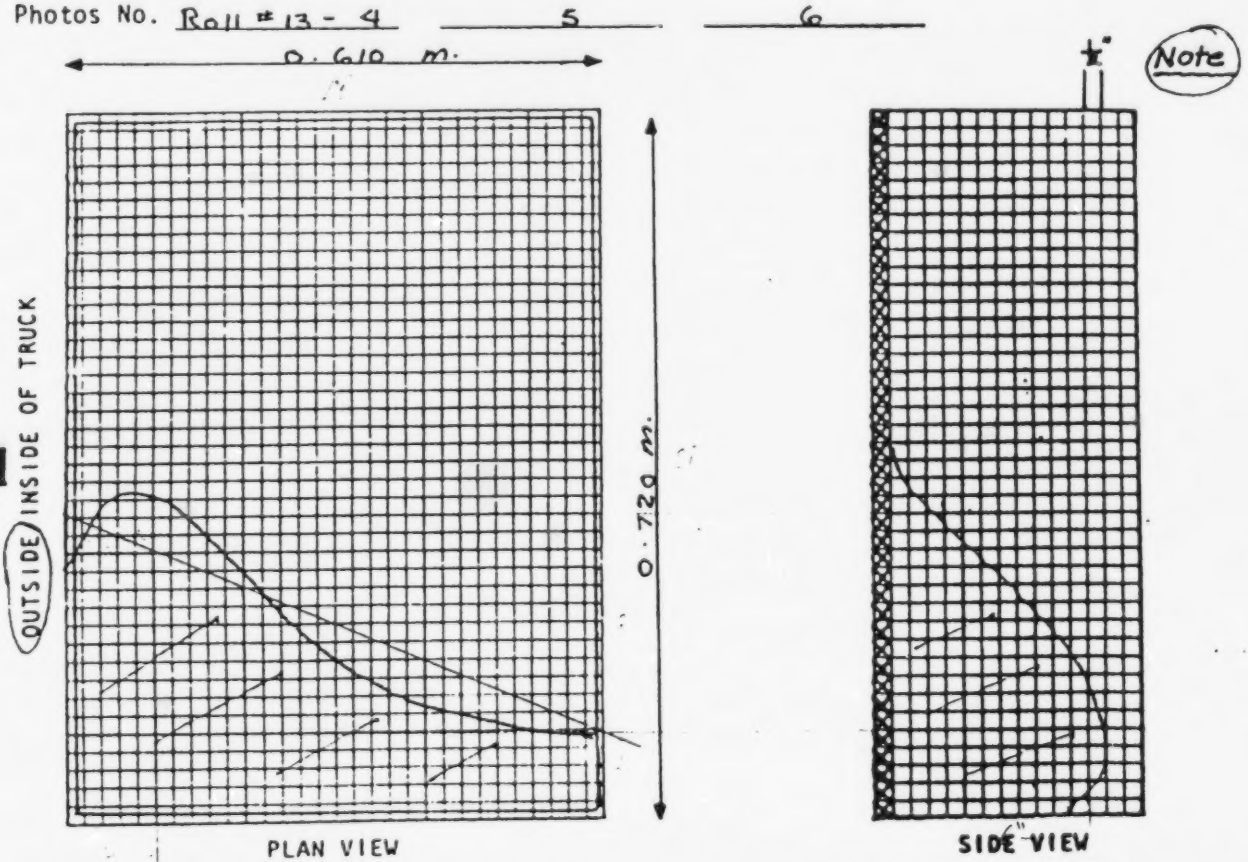
B. Flap Location Passenger side - Behind Front wheels

Type of build-up Ice and Snow

Accumulation Heavy - 6" (150 m.m.)

Any damage to flap NO If so, fill out Form 3.

Photos No. Roll #13 - 4 5 6



NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps National Rubber

Date Feb. 8 / 82 Time 10:45 A.m. Location Winnipeg, MAN.

Tractor I.D. No. 5666 Mileage 187, 199 K.m.

Trailer I.D. No. _____ Mileage _____

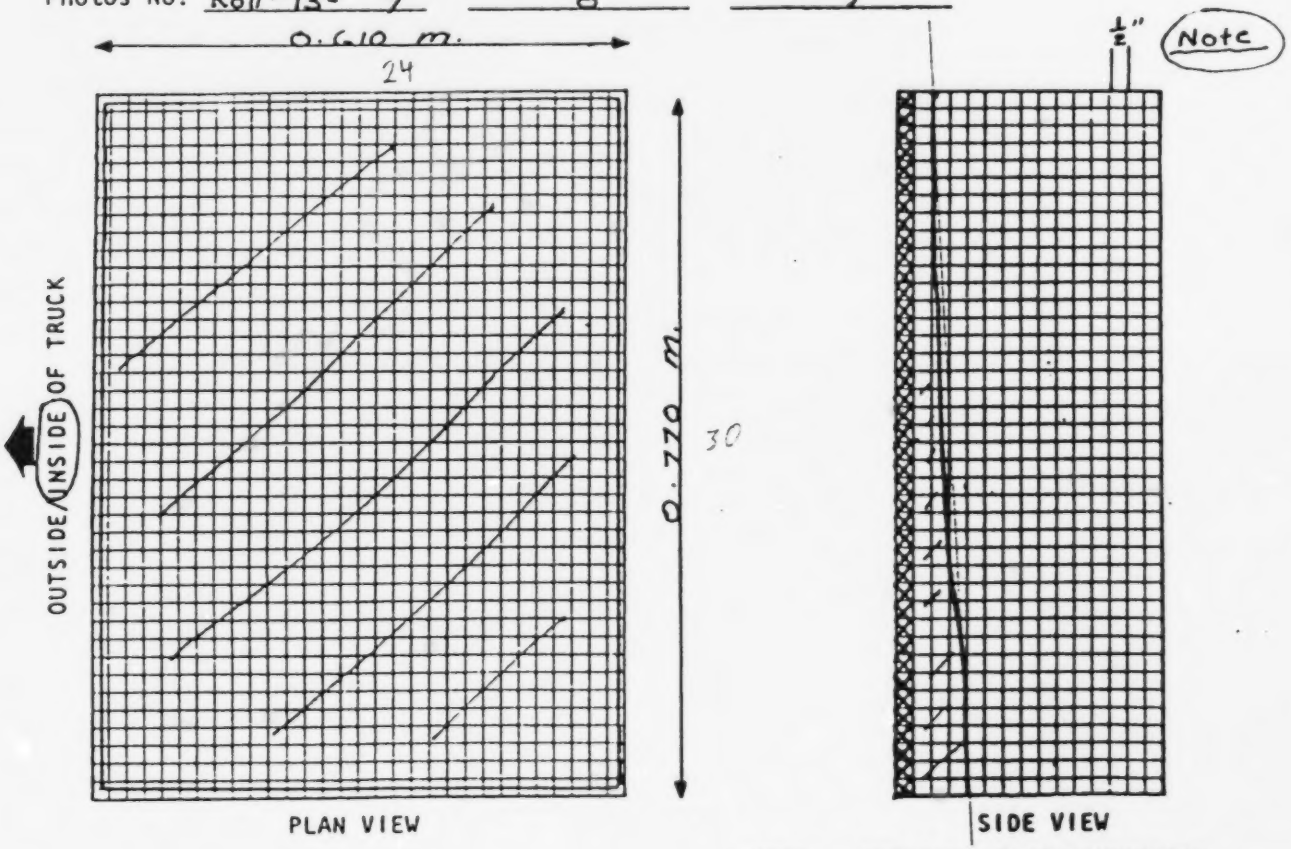
B. Flap Location Driver's side - Behind Rear wheels

Type of build-up Ice and SNOW

Accumulation Light 1½" (35 m.m.)

Any damage to flap NO If so, fill out Form 3.

Photos No. Roll #13- 7 8 9



NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2 INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps National Rubber

Date Feb. 8/82 Time 10:45 A.m. Location Winnipeg, Man.

Tractor I.D. No. 56666 Mileage 187,199 K.m.

Trailer I.D. No. _____ Mileage _____

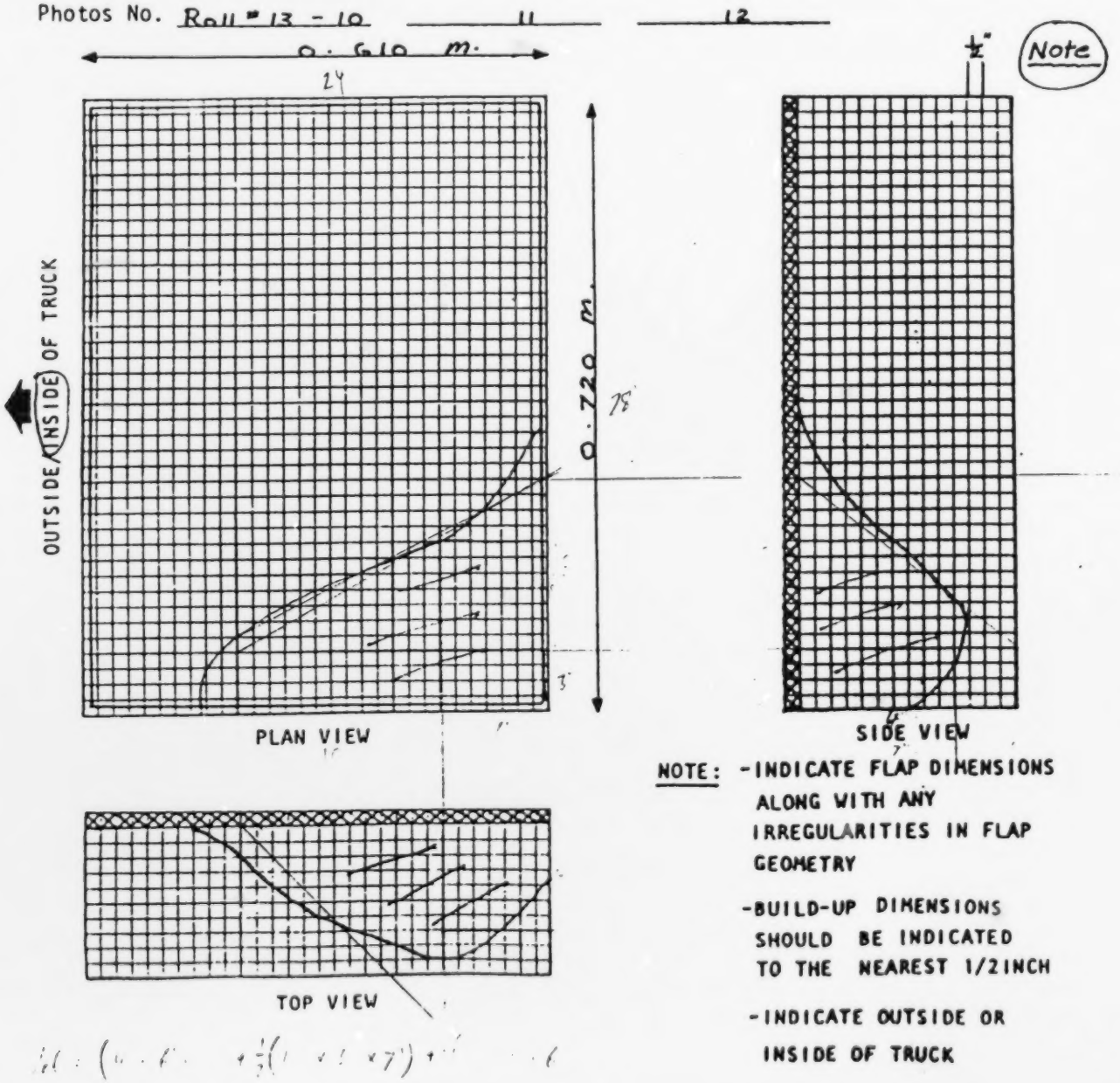
B. Flap Location Driver's Side - Behind Front wheels

Type of build-up Ice and Snow

Accumulation Heavy - 5" (125 m.m.)

Any damage to flap NO If so, fill out Form 3.

Photos No. Roll # 13 - 10 11 12



NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2 INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

FLAP FAILURE OR DAMAGE SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps National Rubber

Date Feb. 8/82 Time 10:45 a.m. Location Winnipeg, MAN.

Tractor I.D. No. 5666 Mileage 187, 199 Km.

Trailer I.D. No. _____ Mileage _____

B. Flap Location Passenger side - Behind Rear wheels

Damage to Flap missing & Replaced Feb. 1/82 mileage - 139, 485 km.

Work Performed Replaced Flap only

Cause of Damage or Failure _____

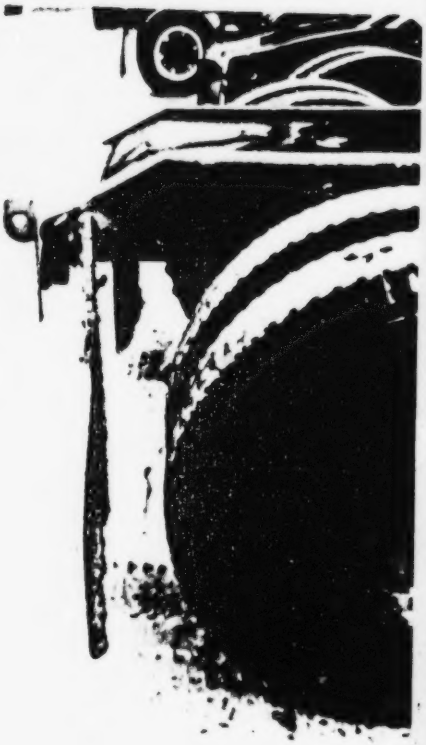
Cold weather caused Flap to crack and break off.

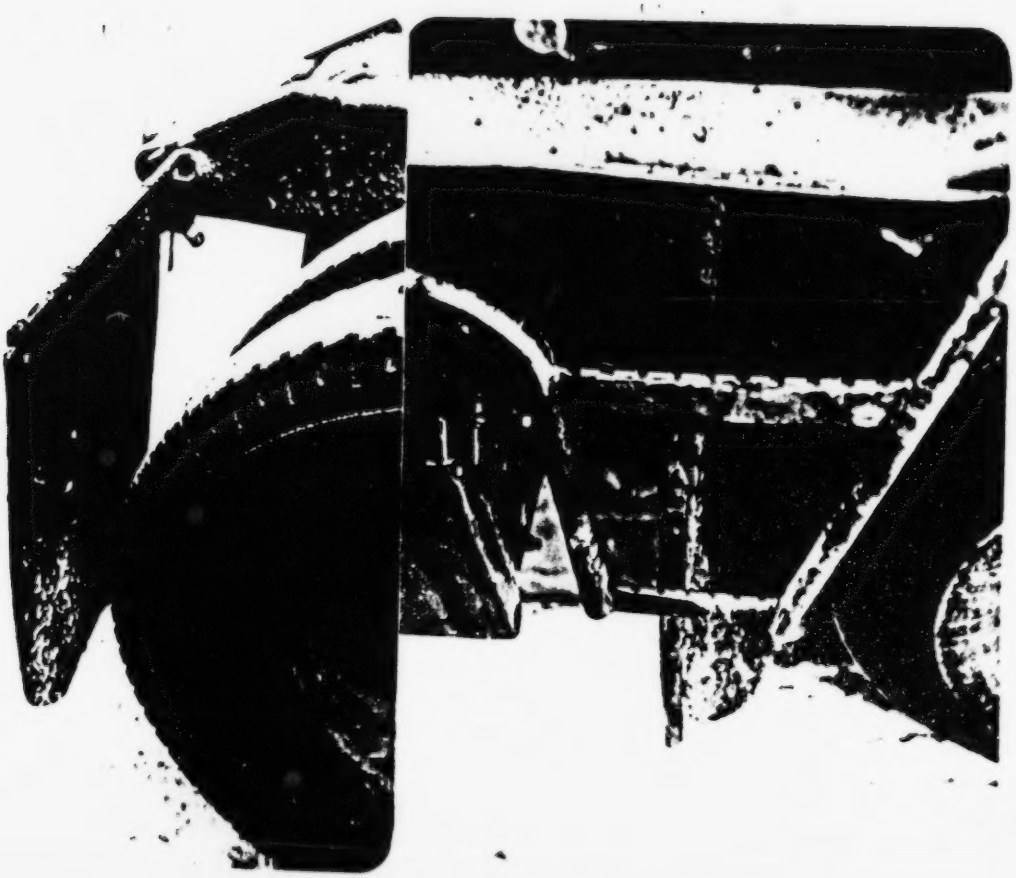
(opinion of Service manager)

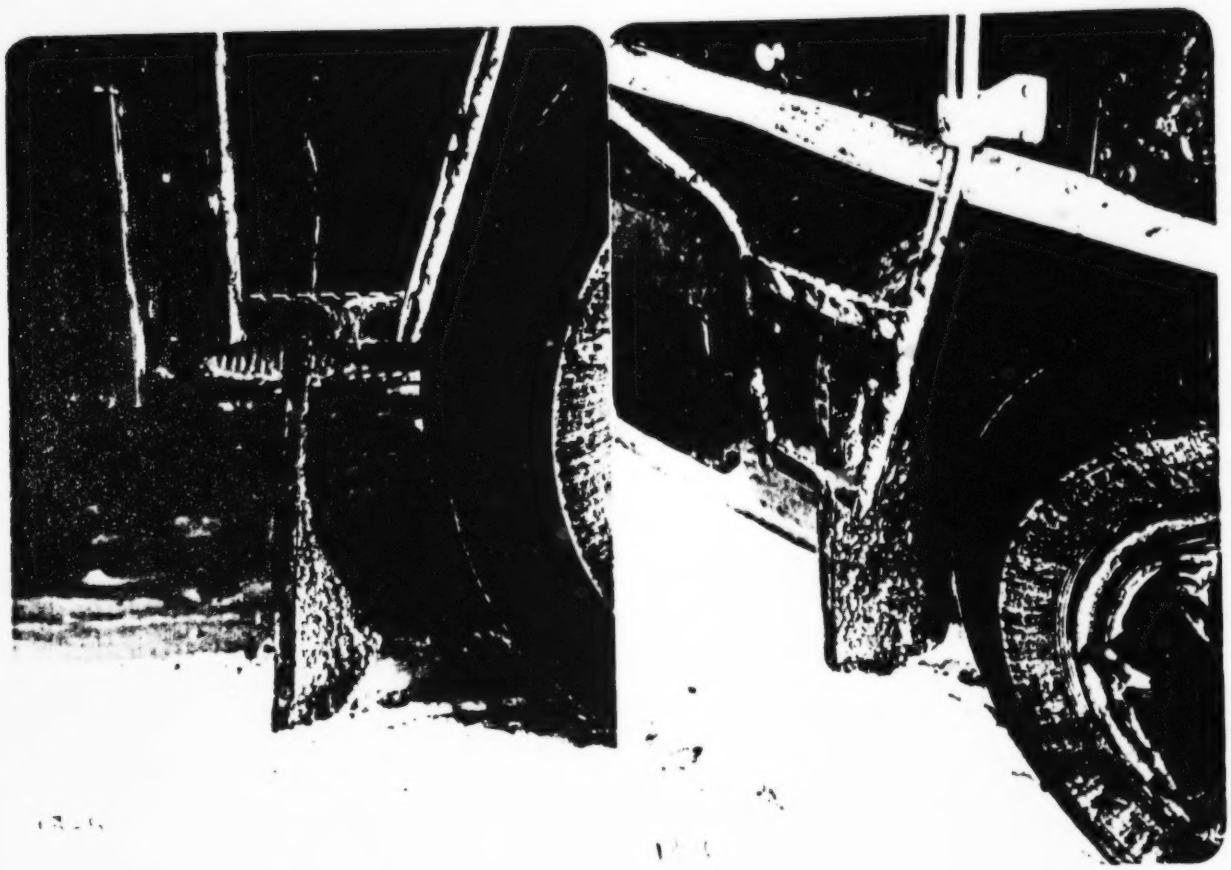
C. Other Comments Service manager feels this Flap is Not Durable enough for cold weather conditions.

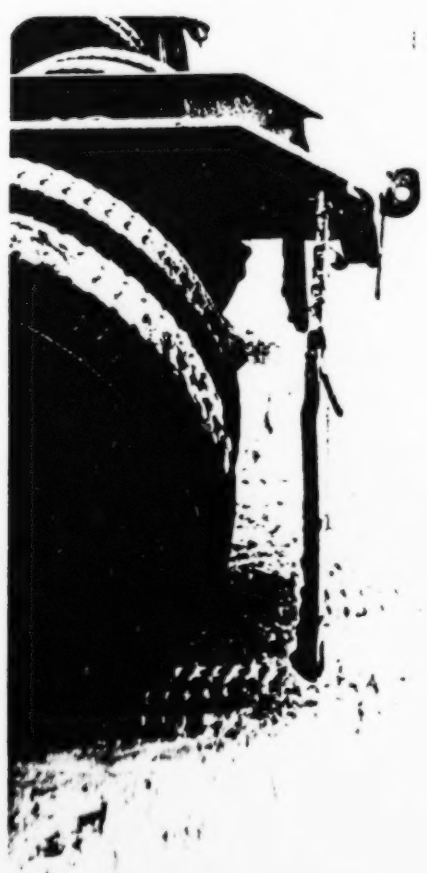
Note this Broken Flap was not Available For Inspection.

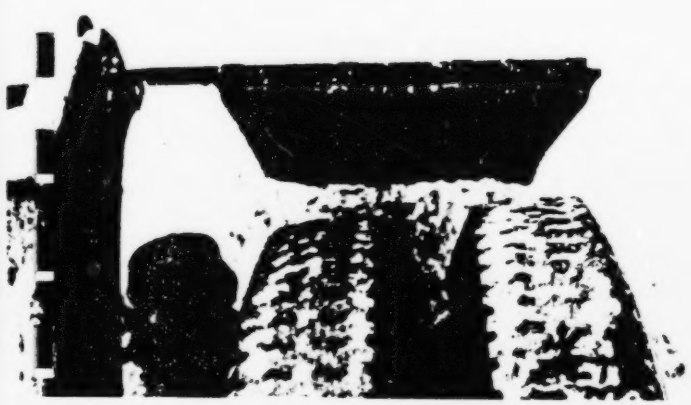
JJL
4

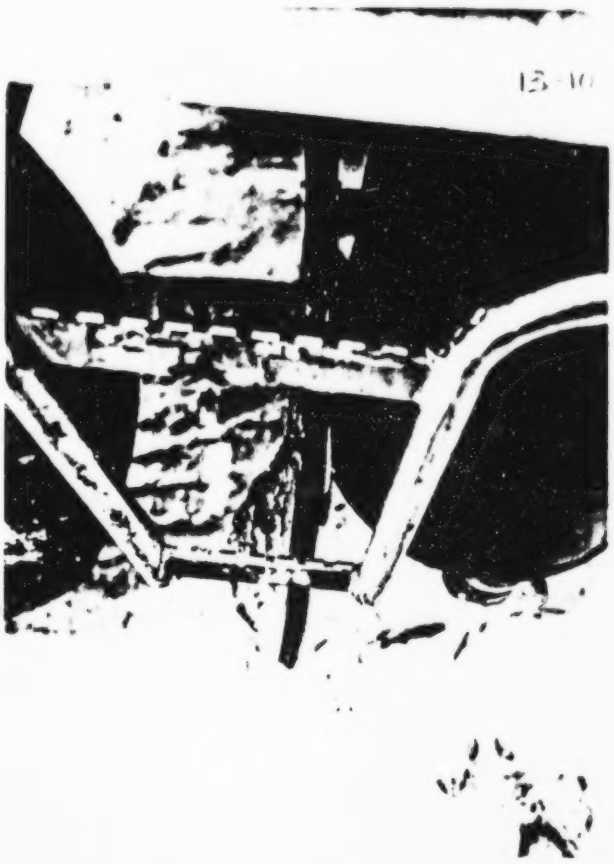












FORM 1

DRIVER INTERVIEW SHEET

Fleet Reimer Express Type of Flaps Monsanto

Date April 5/82 Time 10:00 A.m. Location Winnipeg

Tractor I.D. No. 5664 Mileage 202,271 K.m.

Trailer I.D. No. _____ Mileage _____

Trip Origin Toronto Date March 31- April 5 Time 8:30 A.m.

Highway Used #11 North Stop Made Winnipeg

Average Speed 90 K.m.h.

WEATHER CONDITION

Precipitation Type Snow Intensity Heavy

Temperature -10°C Wind Magnitude and Direction Easterly and Northerly 30 - 50 K.m.h.

Other Drifting Snow - Freezing Rain

ROAD CONDITION

Surface Accumulation yes Type Ice and Snow

Ploughed? No Salted? No

FLAP PERFORMANCE

. Any flap build-up observed? yes - Some

If yes - build-up accumulation ½" to 2" (12 to 50 m.m.)

- type of build-up Ice and Snow
- flap location Behind Front and Rear wheels
- did any of the build-up fall off before reaching your destination? yes
- is the visibility, better/same/worse, than if no build-up was present? Same

. How would you compare the performance of these flaps to other flaps?

Same

. Other comments - Flaps should be bigger.

- Quarter Fender should be made of same material
- moulding over Front wheels should be made of same material.

MONSANTO VEHICLE

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps Monsanto

Date April 5/82 Time 10:00 A.M. Location Winnipeg

Tractor I.D. No. 5664 Mileage 202,271 Km.

Trailer I.D. No. _____ Mileage _____

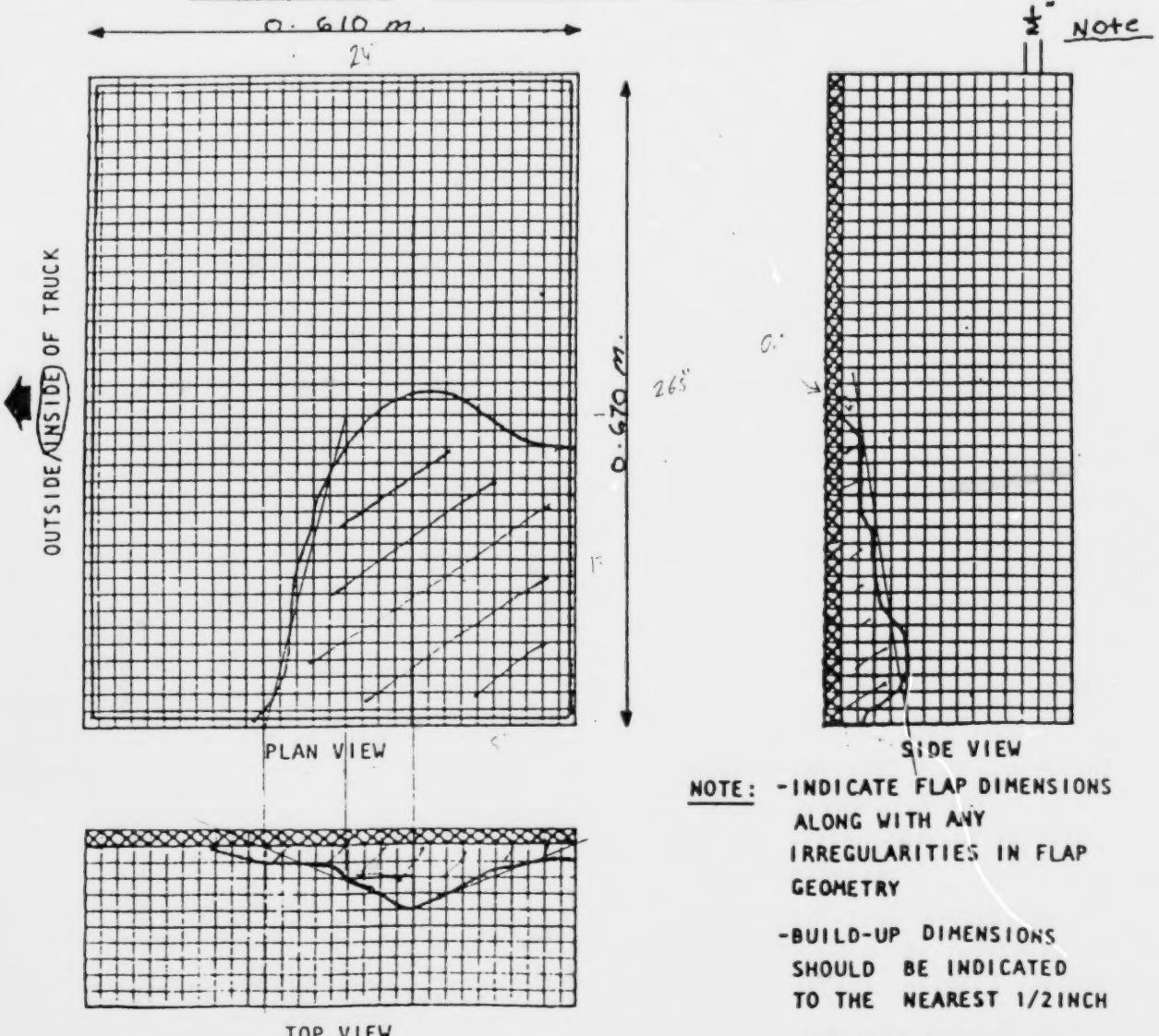
B. Flap Location Drivers Side - Behind Front wheels

Type of build-up Ice and Snow

Accumulation up to 2" (50 m.m.)

Any damage to flap _____ If so, fill out Form 3.

Photos No. Roll #19 - 10 11 12



NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps Monsanto

Date April 5/82 Time 10:00 A.M. Location Winnipeg

Tractor I.D. No. 5664 Mileage 202,271 Km.

Trailer I.D. No. _____ Mileage _____

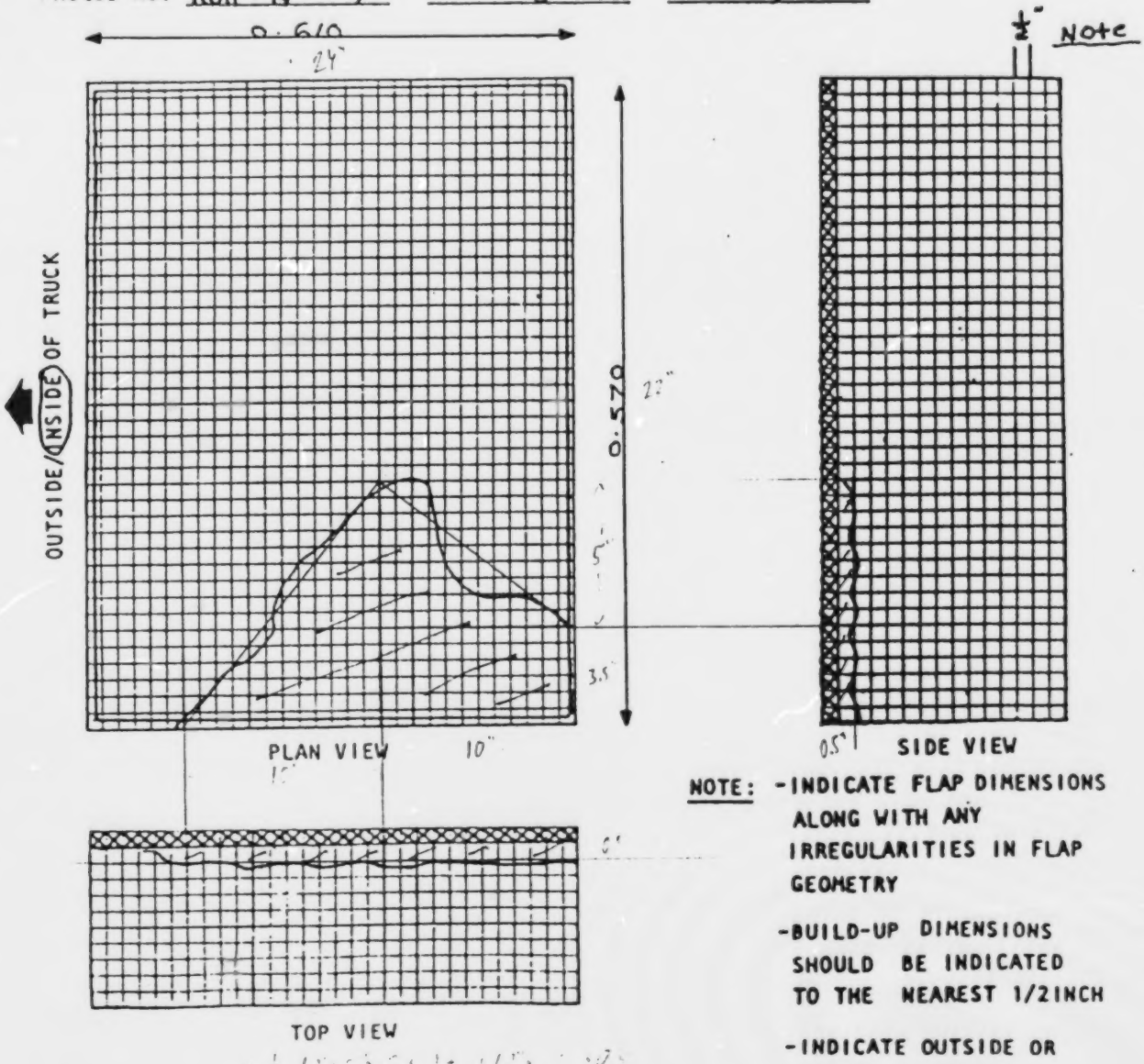
B. Flap Location Drivers side - Behind Rear wheels

Type of build-up Ice and Snow

Accumulation up to ½" (12 m.m.)

Any damage to flap No If so, fill out Form 3.

Photos No. Roll #19 - 7 8 9



NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps Monsanto

Date April 5/82 Time 10:00 A.M. Location Winnipeg

Tractor I.D. No. 5664 Mileage 202,271 Km.

Trailer I.D. No. _____ Mileage _____

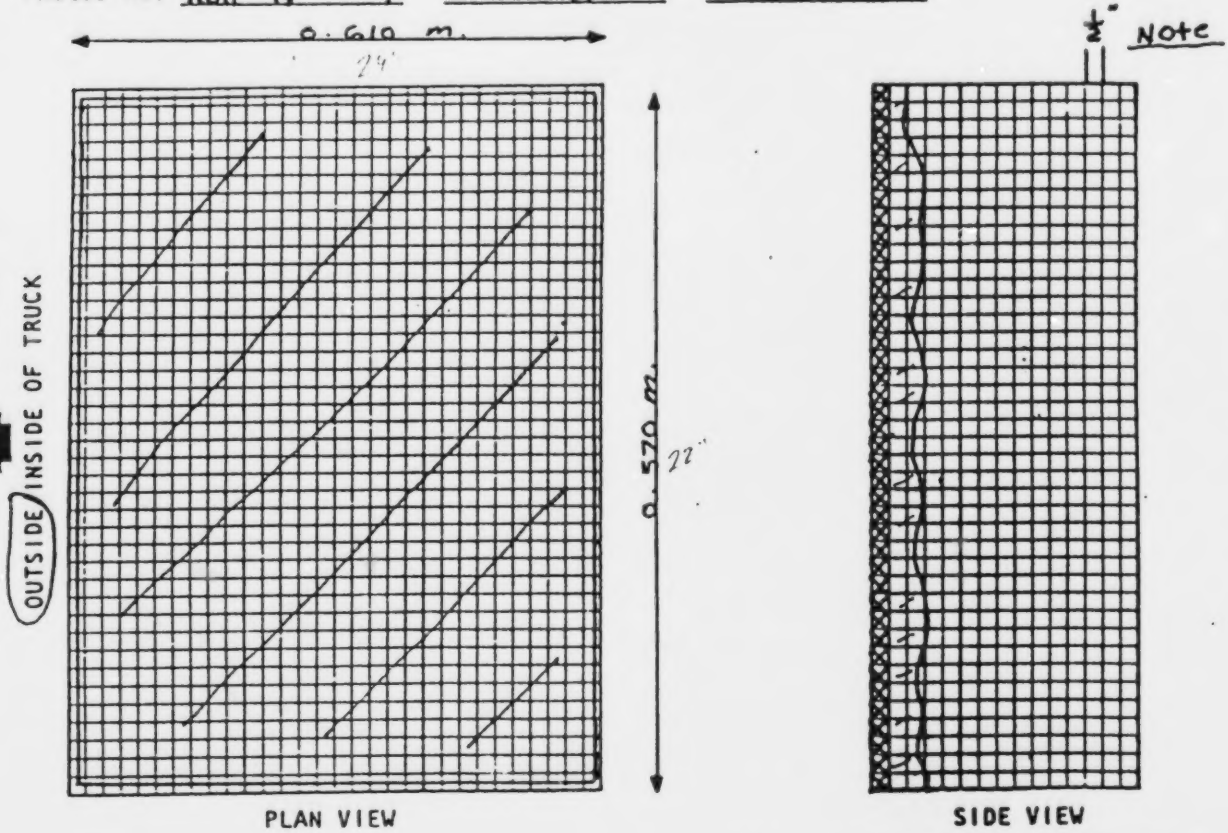
B. Flap Location P.S. Rear (Passenger Side - Behind Rear wheels)

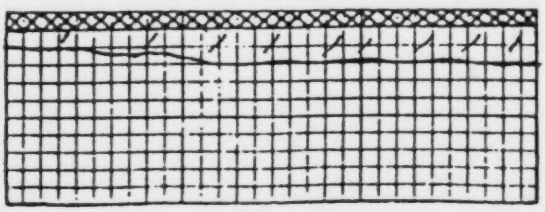
Type of build-up Ice and Snow

Accumulation up to 1" (25 m.m.)

Any damage to flap No If so, fill out Form 3.

Photos No. Roll #19 - 4 5 6





TOP VIEW

NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2 INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

Vol = (24" x 22" x .52") 4" .252 m³

FORM 2

DETAILED FLAP BUILD-UP DESCRIPTION SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps Monsanto

Date April 5/82 Time 10:00 A.M. Location Winnipeg

Tractor I.D. No. 5664 Mileage 202,271 Km.

Trailer I.D. No. _____ Mileage _____

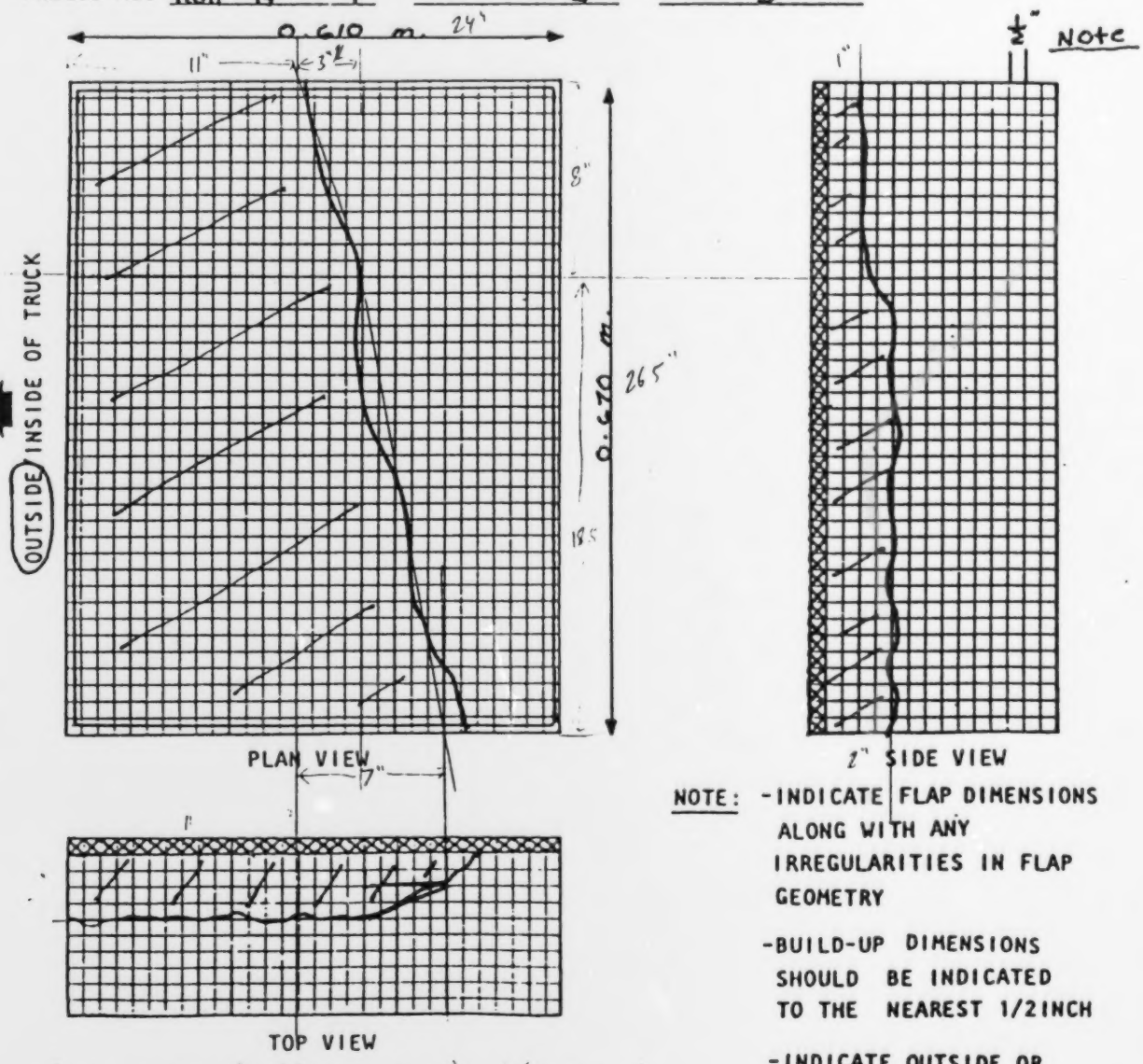
B. Flap Location Passenger Side - Behind Front wheels

Type of build-up Ice and Snow

Accumulation up to 2" (50 m.m.)

Any damage to flap yes If so, fill out Form 3.

Photos No. Roll #19 - 1 2 3



NOTE: -INDICATE FLAP DIMENSIONS ALONG WITH ANY IRREGULARITIES IN FLAP GEOMETRY

-BUILD-UP DIMENSIONS SHOULD BE INDICATED TO THE NEAREST 1/2 INCH

-INDICATE OUTSIDE OR INSIDE OF TRUCK

$V_{ol} = (10" \times 15.5" \times 2") + \frac{1}{2}(4" \times 15.5" \times 1") + \frac{1}{4}(4" \times 18" \times 1")$

FLAP FAILURE OR DAMAGE SHEET

A. If information is not the same as on Form 1, please fill in this section.

Fleet Reimer Express Type of Flaps Monsanto

Date April 5/82 Time 10:00 A.M. Location Wpg.

Tractor I.D. No. 5664 Mileage 202,271 Km.

Trailer I.D. No. _____ Mileage _____

B. Flap Location passenger side - Behind Front wheel

Damage to Flap Split @ Top

Work Performed None

Cause of Damage or Failure Cold weather was a Factor Although the Driver Feels that probably he hit a Lump of Snow or Ice with that Flap.

C. Other Comments Failure occured Sometime Btw. March 1-15th/82 Approx. mileage @ time of Failure - 205,000 K.m. Photo No.s - Roll # 19 - 13 & 14

19-1

19-2

19-5